Country Size, Growth and the Economic and Monetary Union

D I S S E R T A T I O N

zur Erlangung des akademischen Grades

doctor rerum politicarum
(Dr. rer. pol.)
im Fach Volkswirtschaftslehre

eingereicht an der
Wirtschaftswissenschaftlichen Fakultät
Humboldt-Universität zu Berlin und Sciences Po, Paris

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eingereicht am: 5. April 2012
Tag der mündlichen Prüfung: 28. Februar 2012

Abstract

Countries come in all sizes and shapes, and their number is also inseparable from the historical rise and falls of empires and nations. In 2010, 195 entities in the world qualified as sovereign states. Globalisation, while downplaying the importance of military force, has enabled the rise and integration of small countries in the world economy. But what is country size exactly? In economics, it is defined in relative terms: small countries as price takers, and large ones as price makers on international markets. However, country size is a multi-dimensional concept, encompassing various aspects such as geographical area, population, political influence, military clout, domestic market, exports, capital flows, to cite a few. How such a multi-faceted gathering of idiosyncrasies influences economic performance and in particular GDP growth is therefore a complex issue; one that requires an interdisciplinary approach including econometrics, political economy analysis and macro-economic modelling.

The second chapter focuses on the inclusion of country size in a two-country monetary-union model. It features micro-foundations, New-Keynesian and DSGE (Dynamic Stochastic General Equilibrium) modelling. The purpose of the model is the analysis of fiscal policies in the context of a heterogeneous monetary union where countries can differ in terms of size, openness, and price rigidities. Original features are introduced to ensure on the one hand, that the cost of debt increases with the indebtedness level as well as the stationarity of the model and on the other hand, to replicate the making of discretionary fiscal policy in the monetary union. Stochastic simulations for economic and fiscal policy shocks in both closed and open-economy settings flesh out the model's dynamics.

In the third chapter, using the monetary-union model previously developed, we simulate different fiscal policies – an increase in government spending and tax cuts – in response to a crisis and comparatively assess their effectiveness. We rely on deterministic simulations to further the understanding of the workings of a heterogeneous monetary union, fiscal externalities and their implications for national economic policies. We detail how countries of different sizes react differently to their own and their neighbours' fiscal policies to determine what type of size-appropriate fiscal policies may cushion GDP growth in the wake of a crisis. Contrary to Cwik

and Wieland (2009), we contend that the spillovers of fiscal stabilisation policies are positive and non negligible. In this chapter we also assess the effects of "internal devaluation" on countries of the monetary union and whether it may provide an exit out of the sovereign debt crisis.

The fourth chapter broadly tackles the issue of country size and economic performance from an empirical perspective. We carry out the analysis by considering not only country size and its interactions with GDP growth, but also by taking into account the link between country size and business cycle volatility. To investigate these relationships, we used Principal Component Analysis (PCA) to develop an original country-size index that includes population, GDP and the surface area of countries. This indicator enables us to avoid the shortcomings of either a purely demographic measure or one based on GDP rankings and to capture a more complete size effect. Using a panel data set of 163 countries for 1960–2007, we find, contrary to Rose (2006), that country size has a significant and negative impact on economic performance for all countries and within certain groups, i.e., small countries, OECD and even the BRICs (Brazil, Russia, India and China). In our analysis, we also isolate the scale or country-size effect from those of several economic variables, especially that of trade openness. We show that there is a negative relationship between country size and volatility independent of trade openness, extending Furceri and Karras's (2007) results, especially for small countries. Our results are robust to the inclusion of several control sets, country size specifications and detrending methods. The estimations for the PCA size index that we introduced support our assumption that, when accounting for growth and its volatility, there is more to a country than its population figures. Moreover, we corroborate that trade openness is conducive to long-term growth, but find no evidence that it increases growth volatility. Furthering the analysis of country size and economic performance may require looking into less quantifiable factors such as institutions and policies. For instance, the eurozone, in which we highlighted strong negative relationships between country size, economic performance and volatility, showcases the peculiar interactions at play with country size in the context of a monetary union.

The fifth chapter sheds light on how an original institutional context – namely that of the Economic and Monetary Union (EMU) – makes country size play a particular role in accounting for economic growth. Our focus is on the aggregate growth level, not on its distribution within countries, which would entail a distinct analysis for each Member State. Country size determines a number of economic structures: a greater openness is observed in smaller countries and a heavier reliance on internal demand is observed in larger countries. In the eurozone, country size also impacts on economic performance, as a "size divide" appears between small, and fast-growing economies and larger laggard ones. Furthering the political economy analysis led by Laurent and Le Cacheux (2006), we detail the incentives structure of Member States

according to their size. Indeed, the "one-size-fits-all" rules of the monetary union – namely, the Stability and Growth Pact (SGP) and the European Central Bank (ECB) policy – suit the economic structures and policies of the eurozone smaller economies and hinder those of the larger economies. On the one hand, the SGP constrains larger countries in their ability to fiscally boost internal demand; on the other hand the ECB cannot internalise the negative externality generated by small countries because of their usually higher inflation and encourages price competitiveness policies. These "political economy" hypotheses are econometrically tested, using panel data for the fifteen eurozone countries (1998–2008). The regressions ran separately for large and small countries using dynamic panel estimation methods, documented the emergence of a "size divide" within the eurozone – that is, a sizeable negative effect of demographic size on GDP growth. The "size effect" is even more negative for small countries. These results are robust to different econometric specifications. Further robustness checks consisted in enlarging the scope of the data to run "placebo" regressions on the pre-monetary union period and on countries that opted out of the monetary union. They were useful to comparatively assess the effects of the monetary union and confirm that the "size divide" was indeed a by-product of the monetary union. Theoretical research on the modelling of country size and its implications for the conduct of economic policies in the monetary union should complete these empirical findings and is carried out in the following chapter.

Putting these analyses together, we conclude that country size has an incidence on economic structures of nations and consequently on their pace of growth. Whether this impact is negative, neutral or positive is largely contingent on the international environment in which countries trade and rely on each other for capital, investment and migration flows. In addition to the inner institutional and territorial efficiency levels of countries, economic policies matter most in explaining the impact of country size on growth. In particular, in a monetary union, size-appropriate fiscal policies are more conducive to growth. In the eurozone, the non-acknowledgement of the importance of country size for the sake of sovereign equality between Member States has led to marked differentials in terms of economic performance. However, common policy objectives and interests are crucial to the durability of the monetary union. In the wake of the 2008–2010 financial and sovereign debt crises, it is of paramount importance to understand these asymmetries and their consequences, and accordingly revamp the Stability and Growth Pact so as to better anchor the credibility of the currency area.

Keywords: EMU; Eurozone; Monetary union; European Central Bank; Stability and Growth Pact; Fiscal policy; Country size; Heterogeneity; Growth; Principal component analysis; Business cycle volatility; Political economy.

Zusammenfassung

Länder gibt es in allen Größen und Formen, und ihre Zahl ist untrennbar mit dem historischen Aufstieg und Fall von Reichen und Nationen verbunden. Im Jahre 2010 existieren weltweit 195 geografische Gebilde, die als unabhängige Staaten anerkannt sind. Die Globalisierung hat die Wichtigkeit militärischer Macht reduziert und im selben Zug den Aufstieg und die Integration kleiner Länder in die Weltwirtschaft ermöglicht. Aber was ist die „Größe eines Landes“ genau? Die Ökonomik betrachtet sie stets relativ: kleine Länder als Preisnehmer und große Länder als Preissetzer auf internationalen Märkten. Allerdings ist die „Größe eines Landes“ ein multidimensionales Konzept, das zahlreiche Aspekte wie z. B. geografische Lage, Bevölkerung, politischen Einfluss, militärische Bedeutung, inländische Märkte, Exporte und Kapitalströme einschließt. Zu erfassen, wie solch ein facettenreiches Konglomerat von Eigenschaften die ökonomische Leistungsfähigkeit und inbesondere das BIP-Wachstum beeinflusst, ist daher eine komplexes Unterfangen; ein Unterfangen, das einen interdisziplinären Ansatz erfordert, der Ökonometrie, politische Ökonomie und makroökonomische Modellierung zusammenbringt.

Das zweite Kapitel behandelt die Berücksichtigung der Ländergröße in einem Zwei-Länder-Modell einer Währungsnion. Bei dem Modell handelt es sich um ein mikrofundiertes neukeynesianisches dynamisches Allgemeines-Gleichgewicht-Modell (DSGE-Modell). Zweck der Modellierung ist die Analyse unterschiedlicher Fiskalpolitik im Kontext einer heterogenen Währungsunion; die Heterogenität bezieht sich dabei auf die Ländergrößen, die Offenheit hinsichtlich internationalen Handels und den Grad der Preisrigidität. Zu diesem Zweck führen wir ggü. der existierenden Literatur neue Charakteristika ein, um die die Stationariät des Modell sicherzustellen und die Natur diskretionärer Fiskalpolitik in einer Währungsunion abzubilden. Stochastische Simulationen ökonomischer und fiskalpolitischer Innovationen (Schocks) sowohl unter der Annahme geschlossener als auch offener Volkswirtschaften legen die Dynamik des Modells dar.

Im dritten Kapitel simulieren wir, basierend auf dem in Kapitel 2 entwickelten Modell einer Währungsunion, die Wirkung verschiedener fiskalpolitische Maßnahmen – Erhöhung der Staatsausgaben sowie Steuersenkungen – als Antwort auf eine Krise

und vergleichen ihre Wirksamkeit. Wir verwenden deterministische Simulationen, um das Funktionieren einer Wähungsunion mit heterogenen Mitgliedsstaaten bei fiskalischen Externalitäten und ihre Implikationen für die nationale Wirschaftspolitik näher zu verstehen. Wir legen detailliert dar, wie Länder unterschiedlicher Größe auf ihre eigene Politik und auf politische Maßnahmen ihres Nachbarstaates reagieren, um herauszufinden, welche Art größenangepasster Fiskalpolitik Einbrüche im Bruttoinlandsprodukt (BIP) im Zuge einer Krise abfangen kann. Im Gegensatz zu Cwik and Wieland (2009) finden wir, dass die auf die Nachbarstaaten übergreifenden Effekte (Spillover-Effekte) stabilisierender Fiskalpolitik positiv und nicht zu vernachlässigen sind. In diesem Kapitel untersuchen wir zudem die Auswirkungen einer „internen Abwertung" auf die Mitgliedsstaaten der Währungsunion und gehen der Frage nach, ob sie einen Ausweg aus der Staatsschuldenkrise bieten kann.

Das vierte Kapitel betrachtet das Thema der Ländergröße und ökonomischer Leistung empirisch. Wir führen eine Analyse, die nicht nur den Zusammenhang von Ländergröße und BIP-Wachstum, sondern auch von Ländergröße und konjunktureller Volatilität untersucht, durch. Um diese Zusammenhänge darzustellen, nutzen wir die Hauptkomponentenanalyse (*Principal Component Analysis, PCA*), mit deren Hilfe wir einen neuartigen Ländergrößen-Index, der Bevölkerung, BIP und Fläche von Ländern kombiniert, berechnen. Dieser Indikator erlaubt es uns, die Unzulänglichkeiten rein demografischer Maßzahlen und der reinen BIP-Betrachtung zu umgehen und Größeneffekte vollständiger zu erfassen. Basierend auf einem Paneldatensatz (Längsschnittstudie), der 163 Länder für den Zeitraum 1960–2007 umfasst, stellen wir – im Gegensatz zu Rose (2006) – fest, dass die Ländergröße einen signifikant negativen Einfluss auf die ökonomische Leistungsfähigkeit hat – sowohl über alle Länder gerechnet als auch innerhalb bestimmter Gruppen, z. B. der kleinen Länder, der OECD-Mitglieder und sogar den „BRICs" (Brasilien, Russland, Indien, China). In unserer Analyse trennen wir zudem die Größe des Ländergrößeneffekts von dem Einfluss diverser anderer ökonomischer Variablen, speziell dem der internationalen Handelsintegration. Wir zeigen, dass es einen negativen Einfluss der Ländergröße auf die Volatilität unabhängig von der Offenheit eines Landes gibt und erweitern damit die Erkenntnisse von Furceri and Karras (2007), v. a. im Hinblick auf kleine Länder. Unsere Resultate sind robust gegenüber der Berücksichtigung zusätzlicher Kontrollvariablen, verschiedener Ländergrößenspezifizierungen und Trendbereinigungsmethoden. Die Schätzungen des PCA-Größenindex, den wir einführen, unterstützen unsere Annahme, dass mit ihm ein Land besser als durch seine reine Bevölkerungszahl beschrieben werden kann, wenn es darum geht, den Einfluss auf BIP-Wachstum und -Volatilität zu erklären. Darüber hinaus erhärten wir den Befund, dass die Marktoffenheit das langfristige Wachstum bestimmt, finden allerdings keinen Beleg dafür, dass sie die Volatilität erhöht. Um die Analyse von Größeneffekten und ökonomischer Leistungsfähigkeit fortzuentwickeln, wird es vermutlich

nötig sein, auch schlechter quantifizierbare Faktoren wie das institutionelle Umfeld und politischen Einfluss zu betrachten. Beispielsweise illustriert die Eurozone, für die wir einen ausgeprägten negativen Zusammenhang zwischen Ländergröße, ökonomischer Leistung und Volatilität finden, die eigentümlichen Interaktionen, die zwischen Ländergröße und anderen Variablen im Kontext einer Währungsunion wirken.

Das fünfte Kapitel beleuchtet, wie ein spezifischer institutioneller Rahmen – nämlich die Europäische Wirtschafts- und Währungsunion (*Economic and Monetary Union, EMU*) – den von der Ländergröße ausgeübten Einfluss auf das Wirtschaftswachstum beeinflusst. Unser Fokus liegt dabei auf dem aggregierten Wachstumsniveau und nicht auf der Einkommensverteilung innerhalb von Ländern, was eine gesonderte Analyse auf der Ebene der einzelnen Mitgliedsstaaten erfordern würde. Die Ländergröße bestimmt eine ganze Reihe ökonomischer Charakteristika: In kleinen Ländern lässt sich ein größerer Grad an Offenheit und in größeren Ländern eine stärkere Abhängigkeit von der Binnennachfrage beobachten. In der Eurozone beeinflusst die Ländergröße auch die ökonomische Leistung, wie anhand eine Kluft zwischen kleinen, schnell wachsenden und größeren, langsameren Ländern deutlich wird (*„size divide"*). Wir entwickeln die von Laurent and Le Cacheux (2006) eingeführte Politische-Ökonomie-Analyse weiter, indem wir die Anreizstruktur der Mitgliedsstaaten in Abhängigkeit von ihrer Größe untersuchen. Tatsächlich stellt sich heraus, dass die auf alle Länder gleich angewandten Regeln der Währungsunion – nämlich der Stabilitäts- und Wachstumspakt (SWP) und die Geldpolitik der Europäischen Zentralbank (EZB) – eher den ökonomischen Strukturen und Politiken der kleineren Staaten zugute kommen und die größeren Staaten tendenziell behindern. Einerseits beschränkt der SWP die größeren Länder in ihrer Fähigkeit, per Fiskalpolitik die Binnennachfrage zu steigern; andererseits kann die EZB die negativen Externalitäten, die von kleinen Ländern generiert werden, wegen deren normalerweise höheren Inflationsraten nicht internalisieren, was Politik, welche die Konkurrenzfähigkeit im Preiswettbewerb steigert, fördert. Diese Hypothesen bezüglich der „politischen Ökonomie" werden im zweiten Kapitel empirisch getestet, wofür wir einen Paneldatensatz für die 15 Euro-Mitgliedsstaaten von 1998 bis 2008 nutzen. Die Regressionen wurden unter Verwendung dynamischer Paneldaten-Analyseverfahren separat für größe und kleine Länder durchgeführt und dokumentieren das Bestehen eines „Size-Divide" in der Eurozone – d. h. eines deutlichen negativen Einflusses der Bevölkerungszahl auf das BIP-Wachstum. Für kleine Länder ist dieser Größeneffekt noch stärker negativ ausgeprägt. Diese Ergebnisse sind robust über verschiedene ökonometrische Spezifikationen hinweg. Weitere Robustheitsüberprüfungen bestanden darin, die Datenbasis zu verbreitern und „Placebo"-Regressionen sowohl für den Zeitraum vor der Währungsunion als auch für Länder, die der Währungsunion nicht beigetreten sind, durchzuführen. Dies erlaubt es uns, den von der Währungsunion

ausgeübten Effekt zu isolieren und zu bestätigen, dass es sich bei dem „Size-Divide“ tatsächlich um eine Nebenwirkung der Währungsunion handelt.

Aus der Zusammenschau der Ergebnisse dieser Analysen schließen wir, dass die Ländergröße einen Einfluss auf die ökonomischen Strukturen von Staaten und folglich die Geschwindigkeit ihres ökonomischen Wachstums hat. Ob dieser Einfluss negativ, neutral oder positiv ist, wird zuvorderst von dem internationalen Umfeld, in dem Länder miteinander Handel treiben, und der Art, wie sie hinsichtlich Kapital-, Investitions- und Migrationsströmen verflochten sind, bestimmt. Zusätzlich zu den inneren institutionellen und territorialen Effizienzniveaus von Ländern ist die Wirtschaftspolitik der bestimmende Faktor in der Erklärung des Einflusses der Ländergröße auf das Wachstum. Insbesondere in einer Währungsunion, ist es von Bedeutung für das Wachstum, dass die Fiskalpolitik auf die ¨Größe der jeweiligen Länder zugeschnitten ist. In der Eurozone hat die Nichtberücksichtigung der Bedeutung der Ländergröße zugunsten der Gleichbehandlung aller Mitgliedsstaaten zu spürbaren Differenzen hinsichtlich der ökonomischen Leistung geführt. Allerdings muss erwähnt werden, dass gemeinsame politische Ziele und Interessen maßgeblich für die Stabilität der Währungsunion sind. Angesichts der von 2008 bis 2010 andauernden Finanz- und Auslandsverschuldungskrise ist es von größter Wichtigkeit, diese Asymmetrien und ihre Konsequenzen zu verstehen, um den Stabilitäts- und Wachstumspakt so umzugestalten, dass die Glaubwürdigkeit des Währungsraums stärker in ihm verankert ist.

Schlagwörter: WWU; Eurozone; Währungsunion; Europäische Zentralbank; Stabilitäts- und Wachstumspakt; Fiskalpolitik; Ländergröße; Heterogenität; Wachstum ; Hauptkomponentenanalyse ; Konjunkturzyklenvolatilität; Politische Ökonomie .

Résumé

Les pays recouvrent diverses tailles et formes. Leur nombre est aussi intimement lié à l'essor et chutes des empires et nations dans l'Histoire. En 2010, on compte 195 États souverains dans le monde. La mondialisation, en faisant passer au second plan la force militaire, a permis le développement et l'intégration des petits pays dans l'économie mondiale. Mais qu'est ce que la taille d'un pays exactement ? L'analyse économique en donne une définition relative : les petits pays comme preneurs de prix, et les grands comme faiseurs de prix sur les marchés internationaux. Mais la taille des pays est un concept multidimensionnel incluant des aspects variés tels, la superficie, la population, l'influence politique, la force militaire, le marché intérieur, les exportations, les mouvements de capitaux pour n'en citer que quelques uns. Comment une notion multi-facette pétrie des idiosyncrasies nationales influence la performance économique et en particulier la croissance du PIB est donc une question complexe, exigeant une approche interdisciplinaire mêlant économétrie, économie politique et modélisation macro-économique.

Le second chapitre est consacré à l'inclusion de la taille des pays dans modèle d'union monétaire à deux pays. Il s'agit d'un modèle DSGE (Équilibre Général Dynamique Stochastique) micro-fondé, d'inspiration néo-keynésiennne. Le but de la modélisation est l'analyse des politiques budgétaires dans le cadre d'une union monétaire hétérogène où les pays diffèrent en termes de taille, ouverture et rigidités nominales. A cet effet, des caractéristiques originales sont introduites, pour d'une part introduire un coût de la dette croissant avec le niveau d'endettement assurer la stationnarité du modèle et d'autre part répliquer au mieux les politiques budgétaires discrétionnaires dans une union monétaire. Les mécanismes et dynamiques du modèle sont explicités par des simulations de chocs économiques et politiques.

Dans le troisième chapitre, en utilisant le modèle précédemment exposé nous simulons une augmentation des dépenses gouvernementales et des baisses d'impôts en réponse à une crise pour évaluer comparativement leur efficacité. Ces simulations déterministes permettent d'étayer les effets - notamment transnationaux - des politiques budgétaires dans une union monétaire hétérogène, et voire quel type de politique est le plus efficace pour renforcer la croissance du PIB après une récession.

Contrairement à Cwik et Wieland (2009), nous montrons que les effets de spillover des politiques de relance sot positifs et non négligeables. Enfin, nous évaluons les effets d'une politique dite de dévaluation interne sur les pays de l'union monétaire afin de voire si elle présente une alternative viable pour sortir de la crise de la dette souveraine.

Le quatrième chapitre aborde de manière générale et empirique la question de la taille des pays et de la performance économique. Nous considérons non seulement les interactions entre la taille des pays et la croissance du PIB, mais aussi le lien entre la taille des pays et la volatilité du cycle économique. Pour étudier ces relations, nous recourons à l'Analyse en Composant Principal (ACP) et développons un index original de la taille des pays incluant population, PIB et superficie. Cet indicateur nous permet d'éviter les écueils d'une mesure purement démographique et de capturer ainsi un effet de taille plus complet. Utilisant des données de panel pour 163 pays de 1960 à 2007, nous trouvons, contrairement à Rose (2006), que la taille des pays a un impact significatif négatif sur la performance économique pour tous les pays et dans certains groupes, tels les petits pays, ceux de l'OCDE et même les BRICs (Brésil, Russie, Inde et Chine). Dans notre analyse, nous isolons également l'effet de la taille des pays de ceux de plusieurs variables économiques, notamment celui de l'ouverture commerciale. Nous montrons qu'il existe une relation négative entre la taille des pays et la volatilité indépendante du degré d'ouverture, ce qui élargit l'analyse de Furceri et Karras (2007). Nos résultats sont robustes à l'inclusion de plusieurs variables de contrôle, de différentes mesures de la taille des pays et de méthodes d'extraction de la composante cyclique. Les estimations relatives à notre indicateur de taille APC confirment notre hypothèse selon laquelle la composante démographique n'est pas le seul facteur de taille ayant un pouvoir explicatif sur la croissance et sa volatilité. Par ailleurs, nous montrons que l'ouverture commerciale favorise la croissance à long terme, mais ne pouvons mettre en évidence son rôle sur la volatilité. Poursuivre l'analyse des interactions entre taille des pays et performance économique demande que l'on se penche sur des facteurs moins facilement quantifiables tels que les institutions et politiques. Par exemple, la zone euro, dans lesquelles nous avons mis en valeur des relations négatives fortes entre taille des pays, performance économique et volatilité, est une illustration de ces interactions particulières dans un contexte d'union monétaire.

Dans le cinquième chapitre, nous étudions comment un contexte institutionnel original – à savoir cela de l'Union économique et monétaire (UEM) – fait exercer à la taille d'un pays une incidence particulière sur sa croissance économique. Nous considérons le niveau agrégé de croissance et non sa distribution interne, ce qui nécessiterait une analyse distincte pour chaque État Membre. La taille d'un pays détermine un certain nombre de ses structures économiques : une plus grande ouverture est observée dans les petits pays tandis que les grands pays dépendent

davantage de la demande intérieure. Dans la zone euro, pour la décennie précédant la dernière crise financière, on observe également un clivage entre d'une part, des petites économies performantes qui entreprennent des réformes et d'autre part les plus grandes économies à la traîne. Poursuivant l'analyse d'économie politique menée par Laurent et Le Cacheux (2006), on détaille la structure des incitations institutionnelles selon la taille des États Membres. En effet le gouvernement "taille unique" de la zone euro avec d'une part le Pacte de stabilité et de croissance (PSC) et d'autre part, la politique de la Banque Centrale Européenne (BCE), favorise les politiques des petits pays et entrave celles des plus grands. Ainsi le PSC contraint davantage les grands pays dans leur capacité à stimuler la demande intérieure. Par ailleurs, la BCE ne peut neutraliser l'externalité négative générée par la plus forte inflation des petits pays ce qui encourage les politiques de compétitivité-prix . Nous testons économétriquement ces hypothèses d'économie politique. Les estimations dynamiques menée pour les quinze pays de la zone euro entre 1998 et 2008 (données de panel), et dans un souci de robustesse, également pour la période précédant l'UEM et pour les pays de l'Union européenne qui ont choisi de rester en dehors de l'Union monétaire, montrent que le clivage lié à la taille en termes de performance économique est bien le fait de l'UEM. Ces résultats empiriques sur la taille des pays et de ses implications pour la conduite des politiques économiques sont complétés par la modélisation macro-économique du chapitre suivant.

Synthétisant ces analyses, nous concluons que la taille des pays a une incidence sur les structures économiques des nations et par conséquent sur leur rythme de croissance. Le sens de cet impact dépend largement de l'environnement international dans lequel les pays commercent, échangent capitaux, investissements et flux migratoires. En outre le degré d'efficience institutionnelle et territoriale propre à chaque pays, les politiques économiques ont le plus grand pouvoir explicatif de l'impact de la taille des pays sur la croissance. En union monétaire par exemple, des politiques budgétaires appropriées à la taille d'un pays favorisent davantage la croissance. Dans la zone euro, cette importance de la taille des pays est ignorée au bénéfice de l'égalité institutionnelle entre États Membres souverains, ce qui explique en partie les forts différentiels observés en termes de performance économique. Cependant, l'existence d'objectifs politiques et d'intérêts communs est nécessaire à la pérennité de l'union monétaire. Au lendemain des crises financière et de dette souveraine de 2008–2010, il devient primordial de mieux comprendre ces asymétries et leurs effets, afin de rénover en conséquence le Pacte de stabilité et de croissance et ainsi ancrer la crédibilité de l'union monétaire.

Mots-clés : UEM ; Zone Euro ; Union monétaire ; Banque Centrale Européenne ; Pacte de Stabilité et de Croissance ; Politique budgétaire ; Taille des Pays ; Hétérogénéité ; Croissance ; Analyse en Composant Principal ; Volatilité du cycle ; Économie politique.

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1 General Introduction

Countries come in all sizes and shapes, and their number is also inseparable from the historical rise and fall of empires and nations. 2010 GDP growth projections[1] rank among the fastest growing countries very small states such as Qatar (18.5%) and Lebanon (6%), as well as very large economies such as China(10%) and India (8.7%). There are thus no obvious size patterns in accounting for growth, regardless of the overly simplistic fad mottos of the past, such as "small is dangerous" from the Cold War-imbued 1950s, or "small is beautiful" from the 1980s. Indeed, the path-breaking literature on size and growth in the 1960s – with Kuznets (1960) and Robinson (1960), among others – placed emphasis on the vulnerability of small economies in the internationalising world economy, and the ways to resort to it.

However large country size comes with its set of predicaments as well, the more obvious of which being the difficulties encountered in managing large territories and populations. That being said, there seems to be a shift in thought today – with the break-up of empires, the increase in the number of countries established after World War II, the decolonisation process and the end of the Cold War,– the 20th century has witnessed a multiplication of nation-states. In 1945 there were 50 countries in the United Nations; it now counts 192 members. Globalisation, while minimising the importance of military force and bolstering that of trade, has enabled the rise and integration of small countries in the world economy through facilitated access to world markets. Now, in the aftermath of the 2008-10 global economic and financial recession, the BRICs (Brasil, Russia, India, China) – endowed with very large populations, markets and territories – have emerged as relaying engines of the world economy. Contrary to small developing economies, their success has not been based on complete openness to world markets, and while the phenomenon is not likely to bring a new growth paradigm, it certainly hints at a possible "scale effect" of country size on GDP growth.

Large size enables these countries to carry political clout and put pressure on their economic partners. The trend to regional integration may, in this perspective, be seen as

[1] Source: IMF.

a way for smaller countries to reach this critical size in globalised markets. In fact, just as the above two simplifying catchphrases on the benefits of size show, it would be illusory to search for an optimal country size in today's world economy. Should such an optimal size ever be established in theory, it would have very little practical policy implications, for one cannot break up or expand nations at will. However, this is not tantamount to say that size does not matter for economic performance, as Rose (2006) or Backus, Kehoe, and Kehoe (1992) contend.

This dissertation investigates the relationship between country size and growth in particular in the context of a monetary union. Country size has often been taken as exogenous by economists, and its effects not much discussed. Macroeconomic research on scale effects is more limited than micro-econometrics studies as scale effects are less conspicuous at the aggregate level. While our purpose is not to account for the size of countries, we delve into its manifold effects in the following chapters. Additionally, the experience of economic integration in the European Union (EU) – unique in its depth – provides an original canvass for interactions between Members States of different sizes, halfway between the bilateral and global relations.

Definition of key-concepts

First, a few definitions are required. A *country* is generally defined as a populated and governed sovereign territory, usually diplomatically recognised [2]. For economic analysis, a more functional definition is useful: a country is the governed aggregation of diverse and organised economic activities and set of technical factors within political borders. The notion of an economic nation or country can fluctuate in the case of the EU and even more in that of the eurozone. The Economic and Monetary Union (EMU) is in itself a large economic country endowed with a Single Market within which coexist a number of small and medium countries providing common public sovereign goods, such as law and police, even if on either side of national borders the mobility of the factors of production is different, and if banking, financial and political systems vary.

Country size is to be understood in relative terms. An economic functional definition sees small countries as price takers and large countries as price makers on international markets. Country size encompasses a number of dimensions – population, geographical size, GDP, per capita income, natural resources, workforce, human capital, technological level, military capacities, and diplomatic relations – each one yielding different size rank-

[2] Notwithstanding the differences between the concepts, the terms "country", "nation" and "state" will be used interchangeably.

ings, as these dimensions are not necessarily linearly related to one another. Population is most often the retained criterion, as it is correlated with territory size and GDP. Accordingly, one may set an upper threshold on population to categorise small economies. Kuznets (1960) limited it to 10 million inhabitants: 134 fall into that category today. In this dissertation, country size will be proxied alternatively by a compound indicator of GDP, population and surface area, by population for comparability purposes and by relative GDP weight. Differing definitions of country size yield different economic results with respect to growth. Kocher (2003) thus finds a negative relationship between a country's population and its public sector expenditure, but none with GDP. We therefore must bear in mind the relativity of our definitions and thus of the results we may find. To Wittman (2000), who defines a country as "a nexus of public goods", the size of nations is the result of maximising efficient production while minimising political costs within a reliable institutional framework. Success in doing so may increase the size of the country through territorial conquest or immigration, while failure may lead to depletion or break-up of the political entity. Friedman (1977) posits that the country is the largest political unit in which tax collection is coordinated and contends also that the geographical size of nations results from the maximisation of revenue. He points out the existence of contradicting forces impacting on the size of nations, such as the development of tax collections, trade, rent, or the provision labour that imposes boundedness and a certain degree of homogeneity, for at some point diseconomies of scale occur. The size of the domestic market relative to that of the export markets is a helpful indicator to understand the differentiated functioning of small and large economies. While small countries are more open to trade, large countries rely more on national suppliers to satisfy their larger internal demand and spur their growth. As put forward by Katzenstein (1985), and later Alesina, Spolaore, and Wacziarg (2005), there is a negative relationship between country size and openness to trade so that openness may be a crucial criterion in establishing a distinction between small and large economies.

Economic growth is the rate of change of gross domestic product (GDP), and measures the quantity of goods and services produced. We focus on the level of aggregate income at the business cycle frequency, not its per capita distribution within countries in the long run. GDP is indeed an important measure of economic "hard power" and offers a clear international hierarchy in terms of economic size. GDP per capita rankings or "living standards" hierarchies depict a different pecking order, with small European countries often at the top, even if an increase in the GDP of a country is generally taken as an increase in the standard of living of its inhabitants. Considering the GDP aggregate is an

easier way of considering a country's forces and weaknesses even if it may be incomplete. Economic performance can be better fleshed out and evaluated with the four objectives of Kaldor (1971)'s magic square: growth, external balance, employment and inflation. This is a relevant rationale to analyse economic performance, as it includes the four main goals of economic policy: growth, full employment, external accounts and stabilised inflation. Kaldor presented it also as an impossibility square, as economic policy could never attain all four goals at once.

Literature overview and relevant issues

Country size and economic growth: The long-run path of economic growth is one of the central questions of economics. While one of the purposes of this disseration is to see how country size matters for *short-term* growth, the large body of literature on long-term growth may offer us insights as the two types of growth are obviously linked. In a neoclassical framework, like that used by Solow (1956), country size has no effect on growth. In an endogenous growth model, like that described by Aghion and Howitt (1998) or Romer (1994), a larger country size means a large endowment, with scale effects driving economic growth. The argument is straightforward; the larger the country, the larger its workforce and resources – especially in terms of human capital and R&D – to be engaged in industries with increasing returns to scale. This also implies a larger domestic market to sustain growth and that the aggregate catch-up will be quicker. Conversely, Alesina, Spolaore, and Wacziarg (2005) puts forward that small countries benefit more from trade. Indeed pundits no longer focus on the vulnerability of small, open economies in the global economy, but rather on their efficiency and ability to adapt to ever-changing conditions. Kuznets (1960) and Katzenstein (1985) highlight the positive relationship between vulnerability and efficiency. Small countries need a larger outlet than their domestic markets to benefit from scale-effects as the bigger economies do. The constant exposure to international competition from their openness to trade prompts their alignment on the best efficiency standards. And conversely, bigger countries – whose size is also a bulwark against painful changes – often allow archaic structures and obsolete industries to survive.

The new economic geography goes beyond the opposition between extensive and intensive economic growth. Krugman (1991) and Fujita and Krugman (2003) introduce the assumption of increasing rather than constant returns to scale, thus enabling country size to play a role in models for growth and economic activity localisation. Thus, because of the importance of economies of scale, scope, network and endowments, bigger

countries are – thanks to their on-average larger firms – better able to reap the benefits of commercial integration and tend to export products from scale- and R&D-intensive industries. Fujita and Krugman's theories, even if they do not explain nation size, account for core-periphery patterns because of the concentration of monopolistic industries with scale economies in clusters near the markets with the largest demand, better manufacturing structures and network synergies at the expense of other regions. As a consequence, national economies are often driven by leader regions. In Europe, for instance, night-time satellite imagery reveals the famous "blue banana" or industrial core that spreads from Southern England to Northern Italy via the Rhine region.

Reconciling political economy and quantitative macroeconomics: How country size – a multi-faceted collection of idiosyncrasies – influences economic performance, and in particular GDP growth, is therefore a complex issue; one that requires an *interdisciplinary approach*. Exploring the link between country size and growth involves investigating political and institutional settings as well. The new political economy which, following Drazen (2000), studies "how politics affect economic outcomes [...] by the use of the conceptual and technical tools of modern economic analysis" provides a useful analytic grid for the interactions between economics and politics. The root causes for the birth of countries are indeed primarily political. Likewise, as underlined by Eichengreen and Frieden (1993) the EMU was launched because of political will and not out of compliance with the economic criteria of an *optimal currency area* (Mundell (1961)). The monetary union is a political act and, in this sense, the worthy great-granddaughter of the European Coal and Steel Community (ECSC) which was thought up as a device to seal peace by means of industrial cooperation in a war-traumatised Europe. The four pillars of the Economic and Monetary Union – the Single Market and the EU Budget, complemented by the European Central Bank (ECB) and the Stability and Growth Pact (SGP) – are also political constructs.

It is thus relevant to consider how the politics and institutions of the EMU mingle with macroeconomics.Persson (2002) indeed argued that economic events are institution-dependent. Extending Lucas (1976)'s reasoning, EMU settings may change the deep parameters by which policy measures affect the real economy. In the course of our analysis, we will pin down these developments that qualify as "EU- or EMU-induced". It is not so straightforward to spot these contingencies, as with time one no longer questions their origin. One of the more obvious examples is that of trade integration, which would not have reached such a degree had the Single Market not been implemented. There also

exists a "European growth" phenomenon as trade integration and gradual monetary unification have contributed to the synchronisation of business cycles across Member States. Referring to Buti, Roeger, and Veld (2001), the EMU is a unique monetary union in which sovereign countries retain fiscal autonomy – within the rules and criteria of the Stability and Growth Pact – and where the ECB has both goal and instrument independence. One of the purposes of the SGP was to "make fiscal discipline a permanent feature of the EMU" (Buti (2003)), and in a way it succeeded, as fiscal consolidation has been a key consideration of European governments since the implementation of the EMU and it certainly brought about specific growth developments in the area. Interactions between politics and economics have such effects, that an institutional novelty like the EMU may permanently alter economic outcomes in participating countries. As described by Peyton Young (1998) the new social norm thus created becomes self-reinforcing. Fitoussi and Saraceno (2004) refer to it as the "Brussels-Frankfurt consensus". However, as the 2010-11 sovereign debt crisis shows, these new norms – among which the Maastricht criteria – do not guarantee the economic stability they uphold.

International policy coordination and the EMU: The literature on international policy coordination not only considered future forms of monetary union, but also provides insights as to the dynamics of monetary integration and potential strategic problems arising between Members of the EMU. In the 1970s and 1980s, growing economic interdependence between industrialised economies put forward that national policies carry externalities or spillovers. An often-quoted example is that of the1984-1985 U.S. expansionary fiscal policy, which served as a locomotive for the world economy, and this even in the face of restrictive fiscal policies in Germany and Japan.

Modelling these interactions confirmed that the equilibrium reached by non-cooperative macroeconomic policy making is likely to be inefficient as countries fail to take into account the spillover effects of their policies on their partners. However, Frankel and Rockett (1988) or McKibbin and Sachs (1986) showed that in a game-theoretic framework where policymakers act strategically, coordination could under certain conditions allow policies to yield greater welfare to all while avoiding problems of free riding or beggar-thy-neighbour measures. In reality, the attempts at coordinating fiscal policies among the G-7 nations in the 1980s proved relatively unsuccessful and the "locomotive" approach was scrapped. With the collapse of the Bretton Woods system, research on international macroeconomic policy coordination focused mainly on external imbalances and on monetary policy in fixed exchange rate versus flexible exchange rate regimes.

With the generalisation of floating rates, coordination was also a means of protection against third countries. For instance, the creation of the European Monetary System has also been interpreted as a way to deal with the United States' "benign neglect" regarding the U.S. dollar.

These monetary developments were to have a strong impact on fiscal policies interactions. McKibbin and Sachs (1988) showed that, depending on the monetary system in place, fiscal transmission multipliers and spillovers differed. Even if exchange rate agreements were meant to eliminate harmful policy competition such as competitive disinflation, every new set of rules enforces its own forms of strategic behavior, possibly inefficient. According toOudiz and Sachs (1984), the aim of new rules is indeed to replicate cooperative outcomes through independent policies but this does not necessarily rule out suboptimal equilibria, hence the importance of studying the impact of institutional settings on policy coordination. By this token, internal devaluation – which will be analysed at the end of Chapter 3 – may qualify as one of the inefficient equilibria brought about by the new framework of the monetary union.

Policy-making in a heterogeneous monetary union: Asymmetries between Member States make interactions between monetary and fiscal policies more complex, and this, in turn, complicates the optimal task sharing, particularly when it comes to handling adverse economic shocks. Mundell (1961) suggested that a monetary union restricts the formulation of economic policies to react to idiosyncratic shocks: as explained by Buti (2003), EMU institutional designs combine a "strong" central bank with fiscal constraints that constrain the ability of governments to respond to shocks affecting the national economy. This proves particularly detrimental to welfare when the nature and scope of shocks vary substantially across countries within the union as the central bank can indeed exert its stabilisation power only in the face of common or perfectly correlated shocks. However, Cooper and Kempf (2004) have shown that independent fiscal policies in a monetary union can in fact alleviate these idiosyncratic shocks.

The common monetary policy means that countries have lost the possibility of fine-tuning the exchange rate in the face of adverse developments in addition to the power of devaluation to alleviate a sluggish economy. The "gross-tuning" of the ECB was expected to become gradually finer as business cycles synchronised across the eurozone. Unfortunately, national cycles are far from being perfectly correlated, so the policy of the ECB addresses only bluntly the developments in the countries of the eurozone. The policy repartition problem is particularly interesting in the aftermath of the 2008-9 financial

crisis as interest rates are close to their zero lower-bound and government spending has proven to be the only instrument left to stimulate the economy. In this context, Calmfors (1998) argued that as a substitute for exchange rate depreciation, governments would resort to "internal devaluation", i.e., wage or labour cost-moderation policies, to maintain their price competitiveness. This debate is relevant to our study as we examine fiscal externalities and their implications for the best fiscal policy responses to shocks.

A major institutional shortcoming of the monetary union is its lack of appropriate *policy instruments* to sustain growth. The policy assignment approach developed by Tinbergen (1952) describes how each economic policy instrument should be devoted to the attainment of one target so as to reach optimal outcomes. Policy objectives are numerous, conflicting and demand trade-offs. While the ECB has solely pursued price stability in a bid to foster its credibility, the SGP and its 3 percent and 60 percent limits on public deficit and debt fails to make room for the enhanced fiscal cooperation necessary to spur growth and to prevent high yield spreads on sovereign bonds. The tensions already present in the EU are exacerbated in the EMU without a full-fledged economic government, and Europe's Single Market set countries in competition with each other on the basis of their economies and institutions. These inconsistencies hark back to the creation of the monetary union and the disagreement between French and German leaders on its goals, whether central bank independence should be counterbalanced by elected politicians and a European economic government. They illustrate well Rodrik's (2000) "trilemma" between deep economic integration, national sovereignty and democratic politics.

Country size in the monetary union: Another "by-product" of EMU features is the "size divide" in terms of economic performance between small and large countries since the launch of the monetary union. Considering stylised facts of economic indicators of the Member States over the period going back to the creation of the eurozone, Laurent and Le Cacheux (2006) highlight that small countries outperform larger ones in terms of growth, inflation and lower unemployment rates. Paradoxically, large country size cannot be equated with political strength and even less with economic supremacy; the alleged political giants are economic lame ducks. As Member States are considered equally sovereign and granted equal status, the economic rules that preside over the formation of economic policy in the eurozone are the same for all countries, or "one-size-fits-all". Common EU policies, in particular, the EMU, are based on the premise of convergence in nominal and real terms between countries. Indeed, a shared pool of

interests and structures is necessary to implement and sustain any common policy, and so the degree of commonality between countries is assumed to outweigh their differences. However the size of an economy has a great impact on its structures with regards to openness and internal demand, and so on transmission channels for fiscal and monetary policies. Country size is therefore to be managed as a *policy constraint*.

Johnson (1961), commenting on the complexity of considering countries for comparative economic analysis and the importance of policy, noted that: "the nation acquires economic relevance largely in its political capacity as a policy-making unit, endowed with fiscal and monetary powers; but the fact that they have economic policies is about all that nations have in common. Their heterogeneity makes it extremely difficult to disentangle the economic influence of size." *Country size* encompasses a number of dimensions, including economic size reflected by GDP, demographics and territorial size. In this dissertation, we will restrict our attention to the following dimensions of country size: GDP (which exhibits an almost linear relationship with population), trade openness and, to a lesser degree, price rigidities, which, as a pattern, is harder to establish in this case (see Dhyne, Alvarez, Bihan, Veronese, Dias, Hoffmann, Jonker, Linnemann, Rumler, and Vilmunen, 2005). Country size defines the structure of an economy but the performance of a country seems to be a matter of appropriate policies and growth strategies. Thus for small open economies, sensible growth strategies foster price competitiveness, wage moderation, and tax attractiveness. For large countries, the same policies would hamstring domestic demand and reduce the tax intake. At the same time, country size determines a number of economic structures whose implications transcend national borders, for example trade openness, real exchange rates and policy transmission channels. Accordingly, we argue that differences in country size can be considered a rationale for heterogeneity in the EMU. But in the EMU, as we will see, economic policies are limited so that the span of policy choices does not match the array of "sizes" present in the Union – between Malta, with a population of 400.000 inhabitants and a GDP of 5.000 million euros, and Germany for which those figures are respectively 160 times and 400 times larger, with a population reaching 82 million and a GDP of 2.500 billion euros[3]. In particular the Stability and Growth Pact and the monetary policy of the ECB – affect the economic development of each Member State differently, which may account for growth differentials between smaller and larger countries.

[3]Source: Eurostat, 2007 figures.

Position in the literature: Focusing on country size as a source of heterogeneity, this dissertation builds upon the literature on heterogeneous monetary unions. Heterogeneity between countries raises the question of the long-term sustainability of the monetary union. For instance, Suardi (2001) noted that "the decision to launch EMU has focused attention on possible asymmetries in output and prices' responses to the single monetary policy across EU countries". The stark and protracted inflation differentials witnessed in the EMU have been the subject of several studies, and the possible causes of these differentials are numerous: varying degrees of competition on markets (Andres, Ortega, and Valles, 2008), price inertia (Angeloni and Ehrmann, 2004), monetary transmission (Mihov, 2001), the effects of services on inflation (Altissimo, Ehrmann, and Smets (2006)), demand shocks (Canzoneri, Cumby, and Diba (2005)) or trade openness. Country size matters for these differences: smaller countries seem to generate higher inflation through imports and their smaller weights in the central bank's reaction function. Their greater inflationary growth spurs borrowing and investment due to lower real interest rates. Papers focusing on economic performance in the monetary union also highlight an inverse relationship between country size and employment performance (Saint-Paul (2004)) or incentives to implement structural reforms (Duval and Elmeskov (2005)).

Theoretical chapters draw upon the New Keynesian literature, more precisely on Dynamic Stochastic General Equilibrium (DSGE) modelling of monetary unions as in Moons, Garretsen, van Aarle, and Fornero (2007) and Andres, Ortega, and Valles, 2008. Studies of policy optimality in a currency area by Gali and Monacelli (2008) and also by Benigno (2004) oriented our research.

Overall, this dissertation relates to the economic literature on the welfare implications of monetary unions. For instance, Canzoneri, Cumby, and Diba (2005) find that small countries incur larger welfare losses as less weight is given to their inflation rates in the reaction function of the central bank. Mykhaylova (2009) finds no such disadvantage when including capital markets and perfect risk-sharing.Dubois, Hericourt, and Mignon (2007) use a GVAR model to quantify the benefits and costs of euro membership in terms of output and inflation rate; they show that the small countries that joined the eurozone clearly benefited from the enhanced monetary policy credibility, while the outcome is less clear cut for Germany, France and Italy, whose conflicting interests can hardly all be supported by a single monetary regime. Focusing on the effects of fiscal policy, Beetsma, Giuliodori, and Klaassen (2005) empirically demonstrated that small countries of the EMU, because of their greater openness, may benefit more from fiscal expansions led abroad than their larger counterparts would. Assessing the expansionary

effects of different fiscal shocks and using a two-country monetary union model with debt containment mechanisms, Corsetti, Meier, and Müller (2010) find that these effects are important and largely positive when medium-term consolidation is implemented after fiscal expansions.

Dissertation contents

The purpose of this dissertation is thus to investigate the relationship between country size and growth at the international level and comparatively in the Economic and Monetary Union, and to draw up its consequences for the conduct of growth-orientated fiscal policies. To further a global understanding of the link between country size and growth in the EMU, we follow an interdisciplinary approach, including macro-economic modelling, econometrics and political economy analysis. In the following chapters, we take country size as exogenous and consider it a rationale for heterogeneity in terms of economic structures, policy transmissions and incentives between countries.

The second chapter focuses on the inclusion of country size in a two-country monetary-union model. It features micro-foundations, New-Keynesian and DSGE (Dynamic Stochastic General Equilibrium) modelling. The purpose of the model is the analysis of fiscal policies in the context of a heterogeneous monetary union where countries can differ in terms of size, openness, and price rigidities. Original features are introduced to ensure on the one hand, that the cost of debt increases with the indebtedness level as well as the stationarity of the model and on the other hand, to replicate the making of discretionary fiscal policy in the monetary union. Impulse response functions for economic and fiscal policy shocks in both closed and open-economy settings flesh out the model's dynamics.

In the third chapter, using the monetary-union model previously developed, we simulate different fiscal policies – an increase in government spending and tax cuts – in response to a crisis and comparatively assess their effectiveness. We rely on deterministic simulations to further the understanding of the workings of a heterogeneous monetary union, fiscal externalities and their implications for national economic policies. We detail how countries of different sizes react differently to their own and their neighbours' fiscal policies to determine what type of size-appropriate fiscal policies may cushion GDP growth in the wake of a crisis. Contrary to Cwik and Wieland (2009), we contend that the spillovers of fiscal stimulus policies are positive and non negligible. In this chapter we also assess the effects of "internal devaluation" on countries of the monetary union and whether it may provide an exit out of the sovereign debt crisis.

In the fourth chapter, we ask whether country size matters for aggregate growth and its volatility. To capture the effect of country size in its many dimensions, we use Principal Component Analysis (PCA) to develop an original country-size index that includes population, GDP and surface area. Using a panel data set of 163 countries for the period 1960 through 2007, we find that country size has a significant and negative relationship with economic performance for all countries and within certain groups, i.e., small countries, OECD and even the BRICs. We isolate this scale effect from that of trade openness and further highlight a negative relationship between country size and volatility.

The fifth chapter sheds light on how an original institutional context – namely, that of the Economic and Monetary Union (EMU) – makes country size play a particular role in accounting for economic growth at the business cycle frequency. In other words, it sketches a "political economy of size" in the EMU and explores the links between institutional features and economic developments in Member States, in particular how the common monetary policy of the ECB and the fiscal constraints of the SGP affect countries differently. We will see how the institutional settings of the EMU provide an economic framework in which small countries are bound to outperform larger countries. Using panel data for the fifteen eurozone countries (1998-2008), the "size divide',' in terms of economic performance between small and large eurozone countries, or negative correlation between demographic size and GDP growth, appears to be a by-product of the monetary union.

Finally, combining these analyses, we conclude that country size has an incidence on the economic structures of nations, the effects of their policies and therefore on their pace of growth. For this reason there is a need to reinstate the importance of country size and its consequences for the EMU.

2 Liminary: Making Room for Country Size and Fiscal Policy in a Monetary-Union Model

Abstract

This chapter expounds on a micro-founded two-country monetary union model with New-Keynesian features. The modelling purpose is the analysis of fiscal policies in the context of a heterogeneous monetary union where countries can differ in terms of size, openness, price rigidities. To this end, original features are introduced. First, a debt premium or spread paid to financial intermediaries enforces a no-Ponzi condition on the evolution of public and private assets. In the context of the eurozone debt crisis, it is akin to the spread paid by eurozone sovereigns over German bonds. Second, governments do not resort to budget rules. Fiscal authorities maximise an objective function increasing in the public expenditure level while abiding by the implicit debt and deficit limit set by the spread. The steady-state relationships of the model are detailed, in particular is shown how the debt premium ensures the stationarity of the model and how a unique equilibrium is pinned down. Impulse response functions for economic and fiscal policy shocks in both closed and open-economy settings show dynamics and multipliers comparable to those found in the related literature. The model will therefore provide a basis for the in-depth study of fiscal policy spillovers in a monetary union carried out in the next chapter.

Introduction

As Buti, Roeger, and Veld (2001) pointed out, economists have seldom attempted to capture the institutional features of the EMU in their modelling of its monetary and fiscal interactions. This, however, is paramount to understanding monetary and fiscal interactions in a heterogeneous monetary union. This paper provides theoretical insights into this question, relying on a micro-founded two-country monetary union model, with

the actual features of EMU (Economic and Monetary Union): a central bank pursuing consumption price stability and an implicit deficit limit. This monetary-union model draws and builds on Andres, Ortega, and Valles (2008), Gali and Monacelli (2008) and Benigno (2004).

The modelling of the government or fiscal authority block differs from this literature to closer match actual policy-making in EMU. The approach taken is deliberately positive – as opposed to normative–, so as to describe recent economic policy interactions in the eurozone. Optimal fiscal policy in a monetary union is therefore not addressed in this paper. In this model, governments optimise discretionary expenditure under the public budget constraint and do not abide by fiscal rules as in Corsetti, Meier, and Müller (2010) for instance. More precisely, fiscal authorities maximise an objective function increasing in the public expenditure level while abiding by the implicit debt and deficit limit set by the spread.

FollowingSchmitt-Grohe and Uribe (2003), the stationarity of the model is ensured by a premium paid on assets to a financial intermediary. It enforces no-Ponzi conditions on the evolution of public and private assets. The cost of debt is increasing in the level of indebtedness, making the public debt and deficit limits implicit: the higher the interest rate and debt premium, the less governments accumulate debt.

There is little agreement on the effects of fiscal policies in the literature. Modelling and calibration choices account for these discrepancies.Mountford and Uhlig (2009), find – with vector autoregression techniques on US data – tax cuts to have larger effects on GDP than deficit-spending expansions in a closed economy. For the EMU, Faia, Lechthaler, and Merkl (2010) show that, in the presence of frictions in the labour market, income tax cuts and hiring subsidies are the fiscal measures that yield the largest multiplier effects on GDP and consumption. The effects of austerity measures on confidence and interest rates can indeed improve growth prospects, but when consumers are highly indebted and interest rates already low, such effects may not be forthcoming. In this model, public consumption is addressed solely to domestic production, increasing government spending has an immediate one-for-one effect on domestic output. With tax cuts, competition in prices and trade across countries mitigate the effects of fiscal stimuli. Consequently, impulse response functions of fiscal policy shocks for closed- and open-economy put forward a larger positive effect on output and consumption for expenditure-vased expansions than for tax cuts.

The remainder of this chapter is organised as follows. Section 1 presents a micro-founded two-country monetary union model, with a particular emphasis on its original

features regarding the fiscal authorities and the financial intermediaries. Steady-state determination and characteristics are fleshed out in Section 2 and 3, before turning to linearisation in Section 4. Section 5 details parameter calibration and potential robustness issues. In Section 6 fiscal dynamics of the model are compared to a fiscal rule specification to check the robustness of ensuing results. Finally Section 7 presents the model dynamics and effects of fiscal policy with impulse response functions in both closed- and open-economy settings.

2.1 Model

This section details a two-country monetary union model with sticky prices, no capital in the production function and in which all goods are traded. We construct a fixed exchange rate version of Obstfeld (2001) and Obstfeld and Rogoff (1995), in which there are two countries with a common monetary authority. Its general structure as regards goods, households, firms, prices and the monetary authority is akin to models of monetary policy in currency unions that have been developed by Benigno (2004) and Gali and Monacelli (2008). It thus features two country with a single central bank and two fiscal authorities. A typical household is both a consumer and a labour supplier. Households own the firms. The latter produce a single differentiated good that can be traded. There is no labour mobility.

The original features of this model reside in the characterisation of fiscal authorities and financial intermediaries. (i) Governments do not solve a social planner's problem. They are subjected to an implicit debt limit and finance their expenditures through consumption (value-added tax) and payroll taxes but they cannot internalise how these variables impact on households. (ii) Financial intermediaries that incur a cost on households' and governments' assets. While there is no productive capital in the model, there is an international financial or bond market. Introducing this feature allows to have differentiated spreads dependent on public indebtedness, a variable that is particularly relevant in the context of the euro sovereign debt crisis and diverging yield spreads.

A simplified version of this model is presented in the next chapter.

2.1.1 Goods Aggregation

Aggregation of production within countries

We assume that a continuum of goods of size one is produced in the monetary union. Goods in $[0, n]$ are produced in country 1, while goods in $]\, n, 1]$ are produced in country 2. In each country, domestic production is aggregated into a domestic good using a Dixit–Stiglitz aggregator with an elasticity of substitution specific to each country. These hypotheses yield the following relationship between the demand for goods produced by firm $y^i(\varepsilon, i)$ and the total demand for production of country i $(Y_t^i)_{i=\{1,2\}}$:

$$Y_t^1 = K_1 \left(\frac{1}{n} \int_0^n y^1(\varepsilon, t)^{\frac{\theta_1 - 1}{\theta_1}} d\varepsilon \right)^{\frac{\theta_1}{\theta_1 - 1}}, \tag{2.1}$$

$$Y_t^2 = K_2 \left(\frac{1}{1-n} \int_n^1 y^2(\varepsilon, t)^{\frac{\theta_2 - 1}{\theta_2}} d\varepsilon \right)^{\frac{\theta_2}{\theta_2 - 1}}. \tag{2.2}$$

where θ_i is the elasticity of substitution of goods in country i and K_i a constant of normalisation[1].

Maximising the bundle under the budget constraint or alternatively, minimising the price for a bundle unit yields the corresponding production prices:

$$P_t^1 = \frac{1}{K_1} \left(\frac{1}{n^{\theta_1}} \int_0^n P^1(\varepsilon, t)^{1-\theta_1} d\varepsilon \right)^{\frac{1}{1-\theta_1}}, \tag{2.3}$$

$$P_t^2 = \frac{1}{K_2} \left(\frac{1}{(1-n)^{\theta_2}} \int_n^1 P^2(\varepsilon, t)^{1-\theta_2} d\varepsilon \right)^{\frac{1}{1-\theta_2}}. \tag{2.4}$$

The resulting relationships between aggregated and retail prices and quantities read:

$$y^1(\varepsilon, t) = \frac{K_1^{\theta_1 - 1}}{n^{\theta_1}} \left(\frac{P^1(\varepsilon, t)}{P_t^1} \right)^{-\theta_1} Y_t^1, \tag{2.5}$$

$$y^2(\varepsilon, t) = \frac{K_2^{\theta_2 - 1}}{(1-n)^{\theta_2}} \left(\frac{P^2(\varepsilon, t)}{P_t^2} \right)^{-\theta_2} Y_t^2. \tag{2.6}$$

Aggregation of private consumption

In both countries, households have access to the aggregated goods produced by each country; domestic and foreign goods are partial substitutes. Private consumption of good

[1] We take $K_1 = n^{\theta 1/(\theta 1 - 1)}$ and $K_2 = (1-n)^{\theta 2/(\theta 2 - 1)}$ to simplify the algebra.

i is denoted $C_{i,t}$. It represents the total consumption of good i in both countries and differs from private consumption in country i, denoted C_t^i. We have the following relationships:

$$C_{i,t} = C_{i,t}^1 + C_{i,t}^2, \tag{2.7}$$

$$C_t^i = C_{1,t}^i + C_{2,t}^i, \tag{2.8}$$

and

$$C_t^i = \frac{{C_{i,t}^i}^{1-\alpha_i} {C_{j,t}^i}^{\alpha_i}}{(1-\alpha_i)^{1-\alpha_i}\alpha_i^{\alpha_i}}, \tag{2.9}$$

where C_t^i is the private consumption of country i and $C_{j,t}^i$ is the private consumption in country i of the aggregated goods produced in country j. α_i is the import share of country i. The corresponding consumption price index is given by

$$CPI_t^i = {P_t^i}^{1-\alpha_i} {P_t^j}^{\alpha_i} \tag{2.10}$$

This aggregation yields the following relationships between the demands for domestic and imported goods and their relative prices. The repartition of consumptions between locally-produced goods and foreign ones depends on openness degrees (conveyed by national import shares α_i), the ratio of prices and total domestic consumption:

$$C_{2,t}^1 = \alpha_1 \left(\frac{P_t^1}{P_t^2}\right)^{1-\alpha_1} C_t^1, \tag{2.11}$$

$$C_{1,t}^1 = (1-\alpha_1) \left(\frac{P_t^2}{P_t^1}\right)^{\alpha_1} C_t^1, \tag{2.12}$$

$$C_{1,t}^2 = \alpha_2 \left(\frac{P_t^2}{P_t^1}\right)^{1-\alpha_2} C_t^2, \tag{2.13}$$

$$C_{2,t}^2 = (1-\alpha_2) \left(\frac{P_t^1}{P_t^2}\right)^{\alpha_2} C_t^2. \tag{2.14}$$

We see therefore that imported and domestic consumption in country 1 depend on the terms of trade defined as $T_t = \frac{P_t^2}{P_t^1}$, with elasticities $\alpha_1 - 1$ and α_1, respectively: as expected, the dearer are import prices in relative terms, the more households consume domestically-produced goods. The symmetric holds for country 2.

2.1.2 Households

In both countries, each agent (τ) maximises her intertemporal CES utility function subject to her budget constraint (determined by the recursive law of motion of private assets).

Consumption decision

Agents derive utility from consuming the bundle described above and disutility of labour. Each agent provides a differentiated labour supply that allows her to negotiate her wage.

Hence, this agent solves:

$$\max_{C^i(\tau,t),A^i(\tau,t)} E_0 \sum_{T=0}^{\infty} \beta^T \left(\frac{(C^i(\tau,T) - h_c^i C_{T-1}^i)^{1-\sigma_c^i}}{1-\sigma_c^i} - \kappa \frac{(L^i(\tau,T) - h_l^i L_{T-1}^i)^{1+\sigma_l^i}}{1+\sigma_l^i} \right), \quad (2.15)$$

subject to

$$\begin{aligned} A^i(\tau,t) = &\left(1 + r_{t-1} - \psi\left(\frac{A_{t-1}^i}{P_{t-1}^i \bar{Y}^i}\right)\right) A^i(\tau,t-1) + w^i(\tau,t) L^i(\tau,t) \\ &- CPI_t^i (1+\nu_t^{c,i}) C^i(\tau,t) + B_t^i, \end{aligned} \quad (2.16)$$

where E_0, β are respectively the expectation at the initial time operator and the discount factor; $C^i(\tau)$ is the consumption of agent τ in country i; σ_c^i is the inverse intertemporal elasticity of substitution. κ is the weight assigned to labour in the utility function; σ_l^i is the inverse of the Frisch elasticity. h_c^i, h_l^i are the external habit formation parameters on consumption and labour. $L^i(\tau,t)$ is the labour supply of household τ and $w^i(\tau,t)$ its wage. $A^i(\tau,t)$ is the household's τ asset holdings at the end of period t while A_t^i is country's i aggregate level of assets (see the atomicity assumption explained in the following paragraph on private asset dynamics); r_t is the interest rate set by the monetary authority in the union; ψ is an interest premium on debt (whose function is detailed subsequently). $\nu_t^{c,i}$ is the tax rate on consumption or value-added tax (VAT) through which government expenditure is partially financed. Finally, B_t^i is the bonus or dividend paid by the firm to its employees or owner (if negative, it represents a recapitalisation of the firm).

The Euler equation for this programme is identical across households:

$$E_t \left(\beta \left(\frac{C_{t+1}^i - h_c^i C_t^i}{C_t^i - h_c^i C_{t-1}^i} \right)^{-\sigma_c^i} \frac{1 + r_t - \psi\left(\frac{A_t^i)}{P_t^i \bar{Y}^i}\right)}{\Pi_{t+1}^{c,i} \frac{1+\nu_{t+1}^{c,i}}{1+\nu_t^{c,i}}} \right) = 1, \quad (2.17)$$

where $\Pi^{c,i}_{t+1}$ is the inflation of the consumption price index in country i.

Private asset dynamics

The *aggregate* budget constraint reads:

$$A^i_t = \left(1 + r_{t-1} - \psi\left(\frac{A^i_{t-1}}{P^i_{t-1}\bar{Y}^i}\right)\right) A^i_{t-1} + w^i_t L^i_t - CPI^i_t(1+\nu^{i,c}_t)C^i_t + B^i_t. \tag{2.18}$$

To make the cost of debt increase in the level of indebtedness and also ensure the stationarity of the model (i.e. rule out unit roots), we include a premium on the interest rate ψ, which is akin to a transaction cost on holding assets paid to an international financial intermediary and enforces a "no-Ponzi scheme" condition on the evolution of assets as in Schmitt-Grohe and Uribe (2003) (see Section 2.1.7). This premium depends positively on $a^i_t = \frac{A^i_t}{P^i_t \bar{Y}^i}$, which represents the level of indebtedness of private agents in country i in real terms, $\bar{Y}^i$ being the steady-state value of output in country i.

The premium a household faces depends on the aggregate private asset holdings of the country (or local financial conditions), not on the household's private personal financial position. Thus each household takes the premium as given in its consumption decision (atomicity assumption). As the model will be linearised, only the value of ψ and its first derivative at the steady state will impact the model dynamics. We specify ψ such that $\psi(0) = 0$ and $\frac{\partial \psi(x)}{\partial x}|_{x=0} > 0$. So that both indebtedness and asset holding incur a cost paid to the intermediary, and the value of the premium increases with that of debt as illustrated in Figure 2.1 below.

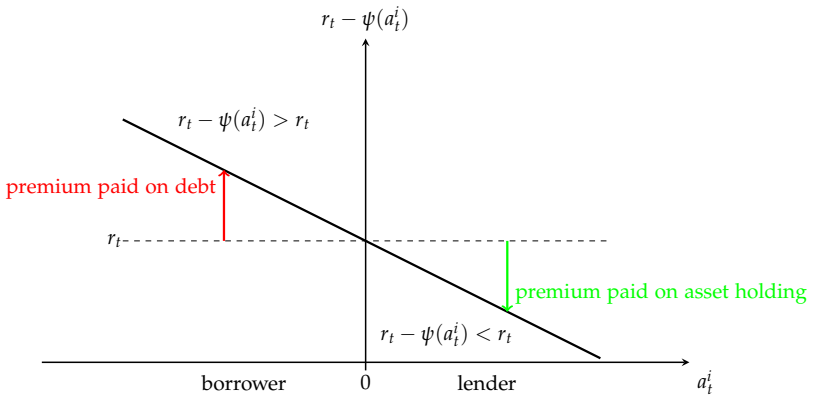


Figure 2.1: Premium ψ paid on debt or asset holdings

If at the aggregate level, country i is a borrower (i.e. $A_t^i \leq 0$), resident households have to pay an interest premium on their debt amounting to $\psi(a_t^i)$. When the country is a lender, returns are reduced by $\psi(a_t^i)$ captured by the intermediary.

Labour supply decision

As we did for consumption goods, we model labour aggregation with a Dixit–Stiglitz function. Unlike consumption goods, labour is considered immobile and cannot be imported or exported. Relationships between labour and wages are therefore similar to those between consumption and prices. θ_w^i denotes the elasticity of substitution of labour. Households choose their labour supply. A labour aggregator or employment agency allocates workers to firms and sets a number of hours worked and an hourly wage as in Erceg, Henderson, and Levin (2000). The relationship between total demand for labour and each household supply reads:

$$L^i(\tau,t) = \left(\frac{w^i(\tau,t)}{w_t^i}\right)^{-\theta_w^i} L_t^i \tag{2.19}$$

Wage setting

We assume wage stickiness à la Calvo, with parameter ξ_w^i denoting the probability not to adjust wages at each period. There is also partial indexation of wages on past inflation of consumption prices according to parameter γ_i. Households solve the following programme:

$$\max_{\tilde{w}^i(\tau,t),\tilde{L}^i(\tau,t,T)} E_t \sum_{t=T}^{\infty} (\xi_t^i \beta)^{T-t} \left(\frac{(C^i(\tau,T) - h_c^i C_{T-1}^i)^{1-\sigma_c^i}}{1-\sigma_c^i} - \kappa \frac{(\tilde{L}^i(\tau,T) - h_l^i L_{T-1}^i)^{1+\sigma_l^i}}{1+\sigma_l^i} \right), \tag{2.20}$$

subject to

$$L^i(\tau,t) = \left(\frac{w^i(\tau,t)}{w_t^i}\right)^{-\theta_w^i} L_t^i, \tag{2.21}$$

$$\begin{aligned} A^i(\tau,t) = &\left(1 + r_{t-1} - \psi\left(\frac{A_{t-1}^i}{P_{t-1}^i \bar{Y}^i}\right)\right) A^i(\tau,t-1) + w^i(\tau,t) L^i(\tau,t) \\ &- CPI_t^i (1+\nu_t^{c,i}) C^i(\tau,t) + B_t^i, \end{aligned} \tag{2.22}$$

and

$$\tilde{w}^i(\tau,t,T) = \tilde{w}^i(\tau,t)\prod_{j=t}^{T-1}(\Pi_j^{c,i})^{\gamma_i} = \tilde{w}^i(\tau,t)\Xi_{w,t}^{T-1}, \tag{2.23}$$

where $\tilde{w}^i(\tau,t)$ is the optimal wage set at time t by household τ and $\tilde{w}^i(\tau,t,T)$ is its wage at time T when not reset between time t and T; $\tilde{L}^i(\tau,t)$ and $\tilde{L}^i(\tau,t,T)$ are the corresponding labour demands. γ_i is the parameter of wage indexation on past inflation and $\Xi_{w,t}^{T-1}$ denotes $\prod_{j=t}^{T-1}(\Pi_j^{c,i})^{\gamma_i}$.

We have the following derivatives for the constraints:

$$\frac{\partial\tilde{L}^i(\tau,t,T)}{\partial\tilde{w}^i(\tau,t)} = -\theta_w^i\left(\frac{\tilde{w}^i(\tau,t)\Xi_t^{T-1}}{w_T^i}\right)^{-\theta_w^i}\frac{L_T^i}{\tilde{w}^i(\tau,t)} \tag{2.24}$$

$$\frac{\partial\tilde{w}^i(\tau,t,T)\tilde{L}^i(\tau,t,T)}{\partial\tilde{w}^i(\tau,t)} = (1-\theta_w^i)\Xi_t^{T-1}\left(\frac{\tilde{w}^i(\tau,t)\Xi_t^{T-1}}{w_T^i}\right)^{-\theta_w^i}L_T^i. \tag{2.25}$$

Thus the first order condition reads

$$0 = E_t\sum_{T=t}^{\infty}(\xi_w\beta)^{T-t}\left(\frac{\tilde{w}^i(\tau,t,T)}{w_T^i}\right)^{-\theta_w^i}L_T^i\Bigg[\left(\tilde{L}^i(\tau,t,T) - h_l^iL_{T-1}^i\right)^{\sigma_l^i} \tag{2.26}$$

$$-\lambda_T\frac{1-\theta_w^i}{\kappa\theta_w^i}\tilde{w}^i(\tau,t)\Xi_t^{T-1}\Bigg] \tag{2.27}$$

$$0 = E_t\sum_{T=t}^{\infty}(\xi_w\beta)^{T-t}\tilde{L}^i(\tau,t,T)\Bigg[\left(\left(\frac{\tilde{w}^i(\tau,t)\Xi_t^{T-1}}{w_T^i}\right)^{-\theta_w^i}L_T^i - h_l^iL_{T-1}^i\right)^{\sigma_l^i} \tag{2.28}$$

$$-\lambda_T\frac{1-\theta_w^i}{\kappa\theta_w^i}\tilde{w}^i(\tau,t)\Xi_t^{T-1}\Bigg], \tag{2.29}$$

where $\lambda_T = \frac{(C^i(\tau,T)-h_c^iC_{T-1}^i)^{-\sigma_c}}{CPI_T^i(1+\nu_T^{i,c})}$ is the Lagrange multiplier associated with the budget constraint. The rest of the calculus (steady state and linearisation) is detailed in the subsequent sections.

2.1.3 Firms

We posit that firms hire a share of the aggregate domestic labour supply so that their labour cost is $w_t^i(1+\nu_t^{w,i})$ in country i at date t. $\nu_t^{w,i}$ is the payroll tax rate levied by the

government on firms. In each country i, firm ε produces the differentiated good $y^i(\varepsilon,t)$ with the following technology:

$$y^i(\varepsilon,t) = \zeta_t^i \left(L_t^i(\varepsilon)\right)^{\alpha} \tag{2.30}$$

$$\text{with cost } w_t^i(1+\nu_t^{w,i})L_t^i(\varepsilon), \tag{2.31}$$

where ζ^i is the total factor productivity in country i modelled as exogenous and α is the production technology parameter.

Price setting

For price setting, we assume a Calvo process in each country. Firm ε can reset its price with exogenous probability $(1-\xi_i)$. Producers know the relationship between their price and the demand for their product and choose their price to maximise their expected profit under that constraint. Firm ε chooses its price $\tilde{P}^i(\varepsilon,t)$ to maximise its expected profit until the next price setting:

$$\max_{\tilde{P}^i(\varepsilon,t)} E_t \sum_{T=t}^{\infty} (\beta\xi^i)^{T-t}\lambda_T^i \left(\tilde{P}^i(\varepsilon,t,T)\tilde{y}^i(\varepsilon,t,T) - w_T^i(1+\nu_T^{w,i})L^i(\varepsilon,t,T)\right), \tag{2.32}$$

$$\text{subject to } \tilde{y}^i(\varepsilon,t,T) = \left(\frac{\tilde{P}^i(\varepsilon,t,T)}{P_T^i}\right)^{-\theta_i} Y_T^i \tag{2.33}$$

$$y^i(\varepsilon,t) = \zeta_t^i \left(L_t^i(\varepsilon)\right)^{\alpha} \tag{2.34}$$

$$\tilde{P}^i(\varepsilon,t,T) = \tilde{P}^i(\varepsilon,t)\prod_{j=t}^{T-1}(\Pi_j^i)^{\gamma_i} = \tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}, \tag{2.35}$$

where the Lagrange multiplier $\lambda_T^i = \frac{(C_T^i - hC_{T-1}^i)^{-\sigma_c}}{CPI_T^i}$ is the marginal utility of consumption in country i in nominal terms.[2] $\tilde{y}^i(\varepsilon,t,T)$ is the demand for goods produced by firm ε of country i at time T when its price was last reset at time t. γ_i is the parameter of price indexation on past inflation and Γ_t^{T-1} denotes $\prod_{j=t}^{T-1}\Pi_j^{i\gamma_i}$. So $\tilde{P}^i(\varepsilon,t,T) = \tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}$ is the price of good ε of country i at time T when its price was last reset at time t. Note that Π_t^i is the inflation of goods produced in country i and differs from inflation of the consumption price index CPI_t^i, which includes inflation from imported goods as well.

[2] Households own the firms, so logically their utility matters for price-setting.

We have the following derivatives:

$$\frac{\partial \tilde{y}^i(\varepsilon,t,T)}{\partial \tilde{P}^i(\varepsilon,t)} = -\theta_i \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{p_T^i} \right)^{-\theta_i} \frac{Y_T^i}{\tilde{P}^i(\varepsilon,t)} \tag{2.36}$$

$$\frac{\partial \tilde{P}^i(\varepsilon,t,T)\tilde{y}^i(\varepsilon,t,T)}{\partial \tilde{P}^i(\tau,t)} = (1-\theta^i)\Gamma_t^{T-1} \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{P_T^i} \right)^{-\theta^i} Y_T^i \tag{2.37}$$

$$\frac{\partial L^i(\varepsilon,t,T)}{\partial \tilde{P}^i(\varepsilon,t)} = \frac{\partial \tilde{y}^i(\varepsilon,t,T)}{\partial \tilde{P}^i(\tau,t)} \frac{\partial L^i(\varepsilon,t,T)}{\partial \tilde{y}^i(\varepsilon,t,T)} \tag{2.38}$$

$$- \theta_i \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{p_T^i} \right)^{-\theta_i} \frac{Y_T^i}{\tilde{P}^i(\varepsilon,t)} \frac{1}{\alpha} \left(\frac{\tilde{y}^i(\varepsilon,t,T)}{\zeta_t^i} \right)^{\frac{1}{\alpha}} \frac{1}{\tilde{y}^i(\varepsilon,t,T)}. \tag{2.39}$$

The FOC reads

$$\begin{aligned} 0 = & \sum_{T=t}^{\infty} (\beta\xi^i)^{T-t} \lambda_T^i \\ & \left((1-\theta^i)\Gamma_t^{T-1} \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{P_T^i} \right)^{-\theta^i} Y_T^i \right. \\ & \left. - \theta_i \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{P_T^i} \right)^{-\theta_i} \frac{Y_T^i}{\tilde{P}^i(\varepsilon,t)} \frac{1}{\alpha} \left(\frac{\tilde{y}^i(\varepsilon,t,T)}{\zeta_t^i} \right)^{\frac{1}{\alpha}} \frac{1}{\tilde{y}^i(\varepsilon,t,T)} \right). \end{aligned} \tag{2.40}$$

Plugging in the constraints:

$$\begin{aligned} 0 = & \sum_{T=t}^{\infty} (\beta\xi^i)^{T-t} \lambda_T^i \\ & \left((1-\theta^i)\Gamma_t^{T-1} \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{P_T^i} \right)^{-\theta^i} Y_T^i \right. \\ & \left. - \frac{\theta^i}{\alpha} \left(\frac{Y_T^i}{\zeta_t^i} \right)^{\frac{1}{\alpha}} \frac{1}{\tilde{P}^i(\varepsilon,t)} \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{P_T^i} \right)^{-\frac{\theta^i}{\alpha}} \right), \end{aligned} \tag{2.41}$$

which can be rewritten as:

$$
\begin{aligned}
0 = & \sum_{T=t}^{\infty} (\beta \zeta^i)^{T-t} \lambda_T^i \\
& \left((1-\theta^i) \Gamma_t^{T-1} \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{P_T^i} \right)^{-\theta^i} Y_T^i \right. \\
& \left. - \frac{\theta^i}{\alpha} (\frac{Y_T^i}{\zeta_t^i})^{\frac{1}{\alpha}} \frac{1}{\tilde{P}^i(\varepsilon,t)} \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{P_T^i} \right)^{-\frac{\theta^i}{\alpha}} \right),
\end{aligned}
\tag{2.42}
$$

The rest of the calculus (steady state and linearisation) is detailed in the subsequent sections.

Dividends redistribution

Firms cannot save or invest, so they redistribute their profits to households. This distribution can be thought of as bonuses B_t^i to employees or dividends to firm owners, and when negative it is similar to a recapitalisation of the firm,

$$B_t^i = P_t^i Y_t^i - w_t^i (1 + \nu_t^{w,i}) L_t^i. \tag{2.43}$$

At the steady state, firms make zero profit and bonuses are equal to zero.

2.1.4 Market Clearing

Every period, markets clear in quantities in both countries:

$$Y_t^i = C_{i,t}^i + C_{i,t}^j + G_t^i. \tag{2.44}$$

In values, this becomes:

$$P_t^i Y_t^i = P_t^i C_{i,t}^i + P_t^j C_{j,t}^i + P_t^i G_t^i + P_t^i C_{i,t}^j - P_t^j C_{j,t}^i, \tag{2.45}$$

which can also be written as follows:

$$P_t^i Y_t^i = CPI_t^i C_t^i + P_t^i G_t^i + P_t^i X_t^i - P_t^j M_t^i, \tag{2.46}$$

where X_t^i gives the exports sold to country j at the price of the domestic good. Likewise, the imports M_t^i are bought from country j at price P_t^j. Because demand for foreign goods is addressed by households only, we have $M_t^i = C_{j,t}^i = X_t^j$.

2.1.5 Monetary Authority, Prices and Inflation

The central bank sets the nominal interest rate R_t common to both countries through a Taylor rule (Taylor, 1993), where it reacts to both the average inflation of the consumption price index over the last year and to the average output gap.

$$R_t = R_{t-1}^{\rho} \left(R^* \prod_{i=t-3}^{t} \Pi_i^{\frac{r_\pi}{4}} Y_t^{r_y} \right)^{1-\rho} \tag{2.47}$$

where $\Pi_t = \frac{\bar{Y}_1}{\bar{Y}_1+\bar{Y}_2} \Pi_t^{c,1} \frac{1+\nu_t^{c,1}}{1+\nu_{t-1}^{c,1}} + \frac{\bar{Y}_2}{\bar{Y}_1+\bar{Y}_2} \Pi_t^{c,2} \frac{1+\nu_t^{c,2}}{1+\nu_{t-1}^{c,2}}$ is the average inflation of consumption in the monetary union, $Y_t = Y_t^1 + Y_t^2$ the total output of the monetary union, R^* is the interest-rate target of the central bank. r_π and r_y are the Taylor rule weights assigned to inflation and the output gap, ρ is the interest-smoothing parameter.

2.1.6 Fiscal Authorities

General approach to the fiscal government block

While most of the previous blocks of the model borrow to the existing DSGE litterature in open economy, the government block is one of its original features. The approach taken is positive not normative, as the objective of this chapter (and the next) is to match fiscal policy interactions as they take place in the EMU, especially to counteract an economic crisis, and infer their consequences for participating Member States.[3]

The major difference with the DSGE litterature is that government behaviour is not described by a spending rule. Instead, the government is assumed to maximize an objective function. We will nevertheless compare our model to an example of budget rule with feedback of public debt on public spending as e.g. in Corsetti, Meier, and Müller (2010) in Section 2.5.

[3] To quote Drazen (2000): "Positive political economy thus asks the question how political constraints may explain the choice of policies (and thus economic outcomes) that differ from optimal policies and the outcomes those policies would imply. To put the same point another way, the mechanisms that societies use in choosing policies [...] imply that the result will often be quite different than what a benign social planner would choose." We thus depart from a normative approach that would spell out optimal fiscal policy in a monetary union. That could be done by having governments solve a Ramsey problem for tax levels subjected to the constraints of the different economic agents.

Three channels for discretionary fiscal intervention

Governments have three possible ways to spur economic activity with one-off discretionary measures: increase public spending or decrease taxes. They can directly stimulate demand through a positive shock on public spending G^i. Governments purchases are exclusively addressed to domestic producers as in Gali and Monacelli (2008), so that their buying price in country i is P_t^i and not CPI_t^i. Since there is no specific government production function, the government does not produce any good or employ any labour force. With this simplification, one assumes that public spending or consumption also includes public production (public services, amenities, administration, etc.).

Covernments can also decrease the tax level on consumption (Value-Added Tax or VAT rate) $\nu^{c,i}$ paid by households or on the payroll tax $\nu^{w,i}$ paid by firms. In fact, tax levels are very stable over time in EU countries. According to Eurostat figures reported in Commission (2010), from 2000 to 2010 VAT rates average in the EU fluctuated very limitedly, between 19.2% and 20.2%. The average implicit tax rate on labour in eurozone countries did not change between 2000 and 2008 at 34.4% of GDP.

So to replicate as closely as possible these facts on tax policy-making, taxes are assumed to be constant and exogenous in the model. Nevertheless, in times of crisis, they may be exogenously modified by the government, mimicking the implementation of one-off special fiscal packages.

Objective function of the government

The objective of the government is to stimulate domestic production and labour, to provide collective good and services, as well as individual consumption, all these dimensions of public intervention are embedded into the variable G as explained earlier. Moreover, the overall level of government spending is assumed to be persistent, as welfare state systems cannot be dramatically reshaped overnight, hence we model the objective function of the government as a CES function of public spending with internal habit formation. Governments maximise their objective function with respect to public spending G, subject to the public budget constraint:

$$\max_{G_t^i} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(G_t^i - h_g^i G_{t-1}^i\right)^{1-\sigma_g^i}}{1-\sigma_g^i}, \tag{2.48}$$

$$\text{subject to } PA_t^i = (1 + r_{t-1} - \psi^g(\frac{PA_{t-1}^i}{P_{t-1}^i \bar{Y}^i}))PA_{t-1}^i + \nu_t^{w,i} w_t^i L_t^i + \nu_t^{c,i} CPI_t^i C_t^i - P_t^i G_t^i. \tag{2.49}$$

where PA_t^i denotes the nominal public assets of country i at the end of period t (negative if the government is a borrower). Note that the atomicity assumption made for households does not hold for governments, the latter are subjected to the public debt premium ψ^g and accordingly habit formation on government consumption is internal. This yields the following Euler equation for government consumption (or discretionary expenditure),

$$E_t \beta \frac{\left(G_{t+1}^i - h_g^i G_t^i\right)^{-\sigma_g^i} + \beta h_g^i \left(G_{t+2}^i - h_g^i G_{t+1}^i\right)^{-\sigma_g^i}}{\left(G_t^i - h_g^i G_{t-1}^i\right)^{-\sigma_g^i} + \beta h_g^i \left(G_{t+1}^i - h_g^i G_t^i\right)^{-\sigma_g^i}} \frac{1 + r_t - \psi^g\left(\frac{PA_t^i}{P_t^i \bar{Y}^i}\right) - \frac{PA_t^i}{P_t^i \bar{Y}^i} \psi^{g\prime}\left(\frac{PA_t^i}{P_t^i \bar{Y}^i}\right)}{\Pi_{t+1}^i} = 1, \tag{2.50}$$

and law of motion for public asset holdings,

$$PA_t^i = \left(1 + r_{t-1} - \psi^g\left(\frac{PA_{t-1}^i}{P_{t-1}^i \bar{Y}^i}\right)\right) PA_{t-1}^i + \nu_t^{w,i} w_t^i L_t^i + \nu_t^{c,i} CPI_t^i C_t^i - P_t^i G_t^i. \tag{2.51}$$

Debt control in the government budget constraint

For governments, ψ^g captures the marginal cost of debt (mechanisms are identical to the ones described for the private sector in the 'Private asset dynamics' paragraph in 2.1.2). This premium paid by the governments on their debt (or assets) ensures that the governments' assets will not permanently depart from their steady state. In other words, the spread paid on sovereign bonds sets an implicit limit on public debt by making credit more expensive as indebtedness level rises. This cost is internalised by the government: it keeps the debt level under check through changes in public expenditure levels. In the context of the eurozone sovereign-debt crisis, this premium may be interpreted as the spread on sovereign yields compared to Germany. The implicit deficit limit on debt enforces indirectly a deficit limit so the model tallies with the Maastrict criteria capping deficit and debt in the countries of the monetary union (at 3% and 60% of GDP respectively).

2.1.7 Financial Intermediation

As explained by Schmitt-Grohe and Uribe (2003), the stationarity of an open economy model is not straightforward. It can be ensured by some modelling elements, which are usually not microfounded (and akin to habit parameters that ensure the hump-shaped response of consumption to shocks). To ensure the stationarity of this open-economy model, we *microfound* one of Schmitt-Grohe and Uribe's proposal and introduce a simplified international financial market. The financial intermediaries capture the private and public debt premia ψ and ψ^g, whose effects on public and private debt are described in the previous subsections of the model on households and fiscal authorities.

We assume that there exists an international financial market for assets (private or public). On the financial market, intermediaries can borrow money from the central bank to finance public or private credit, and conversely borrow money from agents to deposit it at the central bank. Through financial intermediaries, agents can purchase other agents' and governments' assets. The interest rate for the exchange between the central bank and the financial intermediary is the interest rate set by the central bank. The aggregate *cash needs* financial intermediaries borrow from the central bank are:

$$CN_t = -(A_t^1 + A_t^2 + PA_t^1 + PA_t^2). \tag{2.52}$$

The *turnover, costs and profit* of financial intermediaries are

$$\text{Turnover} = -\sum_{i=1,2}\left(r_t - \psi\left(\frac{A_t^i}{P_t^i \bar{Y}^i}\right)\right) A_t^i - \sum_{i=1,2}\left(r_t - \psi^g\left(\frac{PA_t^i}{P_t^i \bar{Y}^i}\right)\right) PA_t^i; \tag{2.53}$$

$$\text{Costs} = r_t CN_t + \Xi(A_t^1,\ A_t^2,\ PA_t^1,\ PA_t^2); \tag{2.54}$$

$$\text{Profit} = \sum_{i=1,2}\psi\left(\frac{A_t^i}{P_t^i \bar{Y}^i}\right) A_t^i + \sum_{i=1,2}\psi^g\left(\frac{PA_t^1}{P_t^i \bar{Y}^i}\right) PA_t^i - \Xi(A_t^1,\ A_t^2,\ PA_t^1,\ PA_t^2); \tag{2.55}$$

where $r_t CN_t$ is the financial cost of this activity and $\Xi(A_t^1,\ A_t^2,\ PA_t^1,\ PA_t^2)$ gives the intermediation and management costs. We assume that financial intermediaries evolve on a perfect competition market with quadratic intermediation and management costs[4] such that profits are equal to zero. Financial intermediaries do not re-inject the cashed-in fees back into the union economy. Therefore developments on the financial market do not affect the rest of the system. As a consequence, the optimisation programme of financial intermediaries is not needed to close our model. One could for instance assume that

[4]Contracts between the financial intermediaries and households or government are embedded in the function ψ and ψ^g. There is no moral hazard, default or collateralisation in our model.

financial activities are based strictly out of the monetary union, for instance in England or in Switzerland. Moreover, we suppose that, at each period, the financial intermediaries clear their position towards the central bank, so that:

$$CN_t = -(A_t^1 + A_t^2 + PA_t^1 + PA_t^2) = 0. \tag{2.56}$$

This last condition imposes that in equilibrium, private and public debts or assets held in the monetary union cancel each other out. This condition may be found restrictive; it is nevertheless comparable to the interbank overnight markets, where banks clear their daily position towards the central bank by lending or borrowing according to the refinancing rate set by the central bank. This ensures that the debt market is Walrassian, i.e. that the laws of motions for three out of four of the assets (public and private in both countries) implies the law of motion for the fourth one (see 2.2.1).

2.2 Steady State

2.2.1 Determination of a Unique Steady State

From the model, we have the following four asset dynamics:

$$PA_t^i = \left(1 + r_{t-1} - \psi^g\left(\frac{PA_{t-1}^i}{P_{t-1}^i \bar{Y}^i}\right)\right) PA_{t-1}^i + \nu_t^{w,i} w_t^i L_t^i + \nu_t^{c,i} CPI_t^i C_t^i - P_t^i G_t^i \tag{2.57}$$

$$A_t^i = \left(1 + r_{t-1} - \psi\left(\frac{A_{t-1}^i}{P_{t-1}^i \bar{Y}^i}\right)\right) A_{t-1}^i + w_t^i L_t^i - CPI_t^i(1 + \nu_t^{i,c}) C_t^i + B_t^i. \tag{2.58}$$

Putting together the four laws of motion for public and private assets gives:

$$\begin{aligned}
&A_t^1 + A_t^2 + PA_t^1 + PA_t^2 = \\
&\quad (1 + r_{t-1})(A_{t-1}^1 + A_{t-1}^2 + PA_{t-1}^1 + PA_{t-1}^2) + w_t^1 L_t^1 + B_t^1 \\
&\quad - CPI_t^1(1 + \nu_t^{1,c}) C_t^1 + w_t^2 L_t^2 + B_t^2 - CPI_t^2(1 + \nu_t^{2,c}) C_t^2 \\
&\quad + \nu_t^{w,1} w_t^1 L_t^1 + \nu_t^{c,1} CPI_t^1 C_t^1 - P_t^1 G_t^1 + \nu_t^{w,2} w_t^2 L_t^2 + \nu_t^{c,2} CPI_t^2 C_t^2 - P_t^2 G_t^2 \\
&\quad - \psi\left(\frac{A_{t-1}^1}{P_{t-1}^1 \bar{Y}^1}\right) A_{t-1}^1 - \psi\left(\frac{A_{t-1}^2}{P_{t-1}^2 \bar{Y}^2}\right) A_{t-1}^2 \\
&\quad - \psi^g\left(\frac{PA_{t-1}^1}{P_{t-1}^1 \bar{Y}^1}\right) PA_{t-1}^1 - \psi^g\left(\frac{PA_{t-1}^2}{P_{t-1}^2 \bar{Y}^2}\right) PA_{t-1}^2;
\end{aligned} \tag{2.59}$$

Rearranged into:

$$\begin{aligned}
&A_t^1 + A_t^2 + PA_t^1 + PA_t^2 = \\
&\quad (1+r_{t-1})(A_{t-1}^1 + A_{t-1}^2 + PA_{t-1}^1 + PA_{t-1}^2) + w_t^1(1+\nu_t^{w,1})L_t^1 + B_t^1 \\
&\quad + w_t^2(1+\nu_t^{w,2})L_t^2 + B_t^2 - CPI_t^1 C_t^1 - CPI_t^2 C_t^2 - P_t^1 G_t^1 - P_t^2 G_t^2 \\
&\quad - \psi\left(\frac{A_{t-1}^1}{P_{t-1}^1 \bar{Y}^1}\right) A_{t-1}^1 - \psi\left(\frac{A_{t-1}^2}{P_{t-1}^2 \bar{Y}^2}\right) A_{t-1}^2 \\
&\quad - \psi^g\left(\frac{PA_{t-1}^1}{P_{t-1}^1 \bar{Y}^1}\right) PA_{t-1}^1 - \psi^g\left(\frac{PA_{t-1}^2}{P_{t-1}^2 \bar{Y}^2}\right) PA_{t-1}^2,
\end{aligned} \tag{2.60}$$

where the last four terms are second order terms since at the steady-state private and public asset are equal to zero. The preceding ones cancel out, noticing a classic GDP decomposition (i.e. total revenue minus total demand in both countries). Taking first-order terms and the definition of cash needs, the sum yields:

$$CN_t = (1+r_{t-1})CN_{t-1}. \tag{2.61}$$

Assuming the nullity of either initial or final conditions of private and public asset in both countries, i.e. CN_0 or $CN_\infty = 0$ is sufficient to have financial intermediaries clearing their position vis-à-vis the central bank at each period.

Any three of the four asset dynamics and the condition of zero cash needs is enough to fully determine the financial market – that is pinning down a unique steady state – while verifying the fourth one. On the contrary, resorting to the four asset dynamic equations would introduce a unit-root in the model (verifying $CN_0 = (1+r_{t-1})CN_{t-1}$).

2.2.2 Steady State Properties

At the steady state, we assume there is no inflation and that the law of one price holds ($\bar{T} = 1$), which induces that all prices (production and consumption) are equal in both countries and across countries at the steady state. In addition, we posit that private and public assets are equal to zero.

Assuming that the law of one price holds at the steady state, the different consumptions are linked as follows:[5]

$$\bar{C}_1^1 = (1-\alpha_1)\bar{C}^1 \tag{2.62}$$
$$\bar{C}_2^1 = \alpha_1\bar{C}^1 \tag{2.63}$$
$$\bar{C}_1^2 = \alpha_2\bar{C}^2 \tag{2.64}$$
$$\bar{C}_2^2 = (1-\alpha_2)\bar{C}^2 \tag{2.65}$$
$$\bar{C}_1^2 = \bar{T}\bar{C}_2^1 \;\Rightarrow\; \alpha_1\bar{C}^1 = \alpha_2\bar{C}^2 \tag{2.66}$$
$$\bar{C}^1 = \bar{C}_1 \text{ and } \bar{C}^2 = \bar{C}_2. \tag{2.67}$$

The last two equalities mean that at the steady state, the trade balance is zero even if countries are asymmetric, i.e. imports equal exports and satisfy the demand for variety.

At the steady state, we have from the market clearing equation

$$\bar{Y}^1 = \bar{C}_1^1 + \bar{C}_1^2 + \bar{G}^1 \tag{2.68}$$
$$\bar{Y}^2 = \bar{C}_2^2 + \bar{C}_2^1 + \bar{G}^2. \tag{2.69}$$

We note $cy_i = \bar{C}_i/\bar{Y}_i$ and $gy_i = \bar{G}_i/\bar{Y}_i$, the share of private and public consumption in each country's GDP and $\theta = \frac{\bar{Y}_1}{\bar{Y}^2}$, the relative size of production of country 1 and 2. Since consumption in both countries cannot exceed total production, we have:

$$1 = cy_i + gy_i \tag{2.70}$$
$$\frac{\alpha_2}{\alpha_1} = \theta\frac{cy_1}{cy_2} \tag{2.71}$$

From the production function we have:

$$\bar{Y}^i = (\bar{L}^i)^{1-\alpha}. \tag{2.72}$$

From the Phillips curve on prices:

$$\overline{PPNR}^i(1+\bar{\nu}^{c,i})(1+\bar{\nu}^{w,i})\bar{L}^i = \alpha\frac{\theta_i-1}{\theta_i}\bar{Y}^i(\bar{\zeta}^i)^{\frac{1}{\alpha}}, \tag{2.73}$$

where $\overline{PPNR}^i = \frac{\bar{w}^i}{\overline{CPI}^i(1+\bar{\nu}^{c,i})}$ is the purchasing power of the net revenue in country i. At the steady-state, the value of gross wages equals the marginal productivity of labour.

[5] $\bar{X}$ is variable X's steady state value.

The Phillips curve on wages yields:

$$\left(\bar{L}^i(1-h_l^i)\right)^{\sigma_l^i} = \bar{\lambda}\frac{\theta_w^i-1}{\kappa\theta_w^i}\bar{w} \text{ with } \bar{\lambda} = \left(\bar{C}^i(1-h_c^i)\right)^{-\sigma_c^i}\overline{CPI}(1+\bar{v}^{c,i}), \tag{2.74}$$

where the Lagrange multiplier $\bar{\lambda}$ represents the marginal utility of consumption.

We have:

$$\overline{PPNR}^i = \frac{\kappa\theta_w^i}{\theta_w^i-1}\frac{\left(\bar{L}^i(1-h_l^i)\right)^{\sigma_l^i}}{\left(\bar{C}^i(1-h_c^i)\right)^{-\sigma_c^i}}, \tag{2.75}$$

so that the PPNR equalises the marginal disutility of labour with the marginal utility of consumption.

From the budget constraint of households,

$$\frac{\overline{PPNR}^i\bar{L}^i}{\bar{Y}^i} = cy_i, \tag{2.76}$$

i.e. the ratio of consumption on GDP equals that of wages on GDP because at the steady state dividends are worth zero.

From the budget constraint of governments:

$$\bar{v}^{w,i}\frac{\overline{PPNR}^i\bar{L}^i(1+\bar{v}^{c,i})}{\bar{Y}^i} + \bar{v}^{c,i}cy_i = gy_i \tag{2.77}$$

$$\bar{v}^{w,i}(1+\bar{v}^{c,i}) + \bar{v}^{c,i} = \frac{gy_i}{cy_i} \tag{2.78}$$

meaning that tax intake equals spending and that the government has no asset at the steady state. And we have the following relationship between the two tax rates:

$$\bar{v}^{w,i} = \frac{\bar{Y}^i}{\bar{C}^i(1+\bar{v}^{c,i})} - 1. \tag{2.79}$$

From the Euler equation of households or governments

$$\beta\frac{1+\bar{r}}{\bar{\Pi}_i^c} = \beta\frac{1+\bar{r}}{\bar{\Pi}_i} = \beta(1+\bar{r}) = 1. \tag{2.80}$$

From the Taylor rule

$$\bar{r} = \bar{r}*, \tag{2.81}$$

i.e. the central banker set the interest rate at its target level at the steady-state.

And finally, from the bonuses

$$\bar{Y}^i = \overline{PPNR}^i(1+\bar{v}^{c,i})(1+\bar{v}^{w,i})\bar{L}^i \tag{2.82}$$

which is the definition of GDP as the sum of gross total income.

2.3 Linearisation

2.3.1 Goods Aggregation

Linearising the relationships in Section 2.1.1 gives:[6]

$$\hat{C}^1_{1,t} = \alpha_1\hat{T}_t + \hat{C}^1_t \tag{2.83}$$
$$\hat{C}^1_{2,t} = (\alpha_1 - 1)\hat{T}_t + \hat{C}^1_t \tag{2.84}$$
$$\hat{C}^2_{1,t} = (1-\alpha_2)\hat{T}_t + \hat{C}^2_t \tag{2.85}$$
$$\hat{C}^2_{2,t} = -\alpha_2\hat{T}_t + \hat{C}^2_t \tag{2.86}$$

2.3.2 Output

Production

From Section 2.1.3, we derive:

$$\hat{Y}^1_t = \hat{\zeta}^1_t + \alpha\hat{L}^1_t \tag{2.87}$$
$$\hat{Y}^2_t = \hat{\zeta}^2_t + \alpha\hat{L}^2_t. \tag{2.88}$$

Demands

From the market-clearing equations, we have:

$$\hat{Y}^1 = \frac{\bar{C}^1_1}{\bar{Y}^1}\hat{C}^1_{1,t} + \frac{\bar{C}^2_1}{\bar{Y}^1}\hat{C}^2_{1,t} + \frac{\bar{G}^1}{\bar{Y}^1}\hat{G}^1_t, \tag{2.89}$$
$$\hat{Y}^2 = \frac{\bar{C}^1_2}{\bar{Y}^2}\hat{C}^1_{2,t} + \frac{\bar{C}^2_2}{\bar{Y}^2}\hat{C}^2_{2,t} + \frac{\bar{G}^2}{\bar{Y}^2}\hat{G}^2_t. \tag{2.90}$$

[6] $\hat{X}$ is variable X's log-deviation from its steady state value $\bar{X}$.

By definition $\frac{\bar{C}_1^2}{\bar{Y}^1} = \alpha_2 \frac{\bar{C}^2}{\bar{Y}^1} = \alpha_2 \frac{\bar{C}^2}{\bar{Y}^2\theta} = \alpha_1 c y_1$, and so:

$$\hat{Y}^1 = (1-\alpha_1) c y_1 \hat{C}^1_{1,t} + \alpha_1 c y_1 \hat{C}^2_{1,t} + g y_1 \hat{G}^1_t \tag{2.91}$$

$$\hat{Y}^2 = \alpha_2 c y_2 \hat{C}^1_{2,t} + (1-\alpha_2) c y_2 \hat{C}^2_{2,t} + g y_2 \hat{G}^2_t. \tag{2.92}$$

Dividends

Since profits and dividends are equal to zero at the steady state, we infer that in the linearisation, they represent only a small fraction of output in real terms. Dividends equal output minus the sum of wages and taxes, namely:

$$B^i_t = P^i_t Y^i_t - w^i_t (1+\nu^{w,i}_t) L^i_t. \tag{2.93}$$

Dividing both sides of the equation by P^i_t:

$$\frac{B^i_t}{P^i_t} = Y^i_t - w^i_t (1+\nu^{w,i}_t) \frac{L^i_t}{P^i_t} \tag{2.94}$$

$$\frac{B^i_t}{P^i_t} = Y^i_t - w^i_t (1+\nu^{w,i}_t) \frac{L^i_t}{P^i_t} \frac{(1+\nu^{c,i}_t)}{(1+\nu^{c,i}_t)} \frac{CPI^i_t}{CPI^i_t}. \tag{2.95}$$

Rearranging with $PPNR^i_t = \frac{w^i_t}{(1+\nu^{c,i}_t) CPI^i_t}$ and $RPC^i_t = \frac{CPI^i_t}{P^i_t}$:

$$\frac{B^i_t}{P^i_t} = Y^i_t - w^i_t (1+\nu^{w,i}_t) \frac{L^i_t}{P^i_t} \frac{(1+\nu^{c,i}_t)}{(1+\nu^{c,i}_t)} \frac{CPI^i_t}{CPI^i_t}. \tag{2.96}$$

The linearised equation for dividends is:

$$\frac{B^i_t}{P^i_t \bar{Y}^i} = \hat{B}^i_t = \hat{Y}^i_t - \left(\widehat{PPNR}^1_t + \hat{L}^i_t + \frac{\bar{\nu}^{c,i}}{1+\bar{\nu}^{c,i}} \hat{\nu}^{c,i}_t + \frac{\bar{\nu}^{w,i}}{1+\bar{\nu}^{w,i}} \hat{\nu}^{w,i}_t + \hat{RPC}^i_t \right). \tag{2.97}$$

Euler Equations

We assume that the fluctuations of private and public assets are small with respect to the steady-state output of the country i.e. $A^i_t/(P^i_t \bar{Y}^i) = \hat{A}^i_t$ and $PA^i_t/(P^i_t \bar{Y}^i) = \widehat{PA}^i_t$ are of first-order magnitude.

Households

Recall the Euler equation for households from the model:

$$E_t\left(\beta\left(\frac{C_{t+1}^i - h_c^i C_t^i}{C_t^i - h_c^i C_{t-1}^i}\right)^{-\sigma_c^i} \frac{1 + r_t - \psi\left(\frac{A_t^i}{P_t^i \bar{Y}^i}\right)}{\Pi_{t+1}^{c,i} \frac{1+\nu_{t+1}^{c,i}}{1+\nu_t^{c,i}}}\right) = 1. \tag{2.98}$$

Taking the log-linearisation around the steady-state yields, noting that $\psi(0) = 0$:

$$1 = \beta\frac{1+\bar{r}}{\bar{\Pi}}\left(1 - \frac{\sigma_c}{1-h_c}\left(\hat{C}_{t+1}^i - (1+h_c)\hat{C}_t^i + h_c\hat{C}_{t-1}^i\right)\right) \tag{2.99}$$

$$\left(1 + \hat{r}_t - \psi\hat{A}_t^i - \hat{\Pi}_{t+1}^{c,i} - \frac{\bar{\nu}^c}{1+\bar{\nu}^c}\left(\hat{\nu}_{t+1}^{c,i} - \hat{\nu}_t^{c,i}\right)\right). \tag{2.100}$$

We can simplify with the steady-state relationship and neglecting second-order terms so that:

$$\hat{c}_t^1 = \frac{\hat{c}_{t+1}^1}{1+h_c} + \frac{h_c\hat{c}_{t-1}^1}{1+h_c} - \frac{1-h_c}{(1+h_c)\sigma_c}\left(\hat{R}_t - \psi\hat{A}_t^1 - \hat{\Pi}_{t+1}^{c,1} - \frac{\bar{\nu}^{c,1}}{1+\bar{\nu}^{c,1}}(\hat{\nu}_{t+1}^{c,1} - \hat{\nu}_t^{c,1})\right) \tag{2.101}$$

$$\hat{c}_t^2 = \frac{\hat{c}_{t+1}^2}{1+h_c} + \frac{h_c\hat{c}_{t-1}^2}{1+h_c} - \frac{1-h_c}{(1+h_c)\sigma_c}\left(\hat{R}_t - \psi\hat{A}_t^2 - \hat{\Pi}_{t+1}^{c,2} - \frac{\bar{\nu}^{c,2}}{1+\bar{\nu}^{c,2}}(\hat{\nu}_{t+1}^{c,2} - \hat{\nu}_t^{c,2})\right) \tag{2.102}$$

where $\psi = \frac{\partial\psi(x)}{\partial x}|_{x=0}$ is such that $\psi(0) = 0$ and $\frac{\partial\psi(x)}{\partial x}|_{x=0} > 0$. The debt premium ψ and the VAT rate $\nu^{c,i}$ affect consumption in the same manner as the real interest rate $\hat{R}_t - \hat{\Pi}_{t+1}^{c,i}$, or in other words add up to the real interest rate borne by households.

Governments

Proceeding like for households' Euler equations, we get:

$$\begin{aligned}\hat{G}_t^1\left(1 + h_g^1 + \beta(h_g^1)^2\right) &= \hat{G}_{t+1}^1\left(1 + \beta h_g^1 + \beta(h_g^1)^2\right) + h_g^1\hat{G}_{t-1}^1 - \beta h_g^1\hat{G}_{t+2}^1 \\ &- \frac{(1-h_g^1)(1-\beta h_g^1)}{\sigma_g^1}(\hat{R}_t - 2\psi^g\widehat{PA}_{t-1}^1 - \hat{\Pi}_t^1),\end{aligned} \tag{2.103}$$

$$\begin{aligned}\hat{G}_t^2\left(1 + h_g^2 + \beta(h_g^2)^2\right) &= \hat{G}_{t+1}^2\left(1 + \beta h_g^2 + \beta(h_g^2)^2\right) + h_g^2\hat{G}_{t-1}^2 - \beta h_g^2\hat{G}_{t+2}^2 \\ &- \frac{(1-h_g^2)(1-\beta h_g^2)}{\sigma_g^2}(\hat{R}_t - 2\psi^g\widehat{PA}_{t-1}^2 - \hat{\Pi}_t^2).\end{aligned} \tag{2.104}$$

As with private consumptions, public consumptions display persistence because of the internal habit formation parameter h_g. Setting $\beta = 0$ in the former equations would make habit formation external. The real interest rate for governments differs from that of households because their consumptions are priced differently, governments buying exclusively domestic production. Also the atomicity hypothesis made for households relative to the asset market does not hold for governments and their debt premia differ (ψ versus ψ^g). Comparing the terms of Euler equations shows that governments are twice as sensitive to the spread on financial markets as households are.

2.3.3 Asset Dynamics

Again, assuming that the fluctuations of private and public assets are small with respect to the steady-state output of the country (i.e. $A_t^i/(P_t^i\bar{Y}^i) = \hat{A}_t^i$ and $PA_t^i/(P_t^i\bar{Y}^i) = \widehat{PA}_t^i$ are of first-order magnitude), we note $\hat{A}_t^i = \frac{A_t^i}{\bar{Y}}$ and $\hat{B}_t^i = \frac{B_t^i}{\bar{Y}}$.

Households

Using the steady state relationships $1 + r = \beta$, and $\bar{w}^i\bar{L}^i = (1 + \bar{\nu}^{c,i})\bar{C}^i$ the households' budget constraint is linearised as follows:

$$\hat{A}_{t-1}^1 = \beta\hat{A}_t^1 - \beta\frac{\bar{C}^1}{\bar{Y}^1}(1 + \bar{\nu}^{c,1})(\hat{w}_t^1 - \bar{\nu}_t^{c,1} - C\hat{P}I_t^1 + \hat{L}_t^1 - \hat{c}_t^1) - \beta\hat{B}_t^1 \tag{2.105}$$

$$\hat{A}_{t-1}^2 = \beta\hat{A}_t^2 - \beta\frac{\bar{C}^2}{\bar{Y}^2}(1 + \bar{\nu}^{c,2})(\hat{w}_t^2 - \bar{\nu}_t^{c,2} - C\hat{P}I_t^2 + \hat{L}_t^2 - \hat{c}_t^2) - \beta\hat{B}_t^2 \tag{2.106}$$

Using

$$\overline{PPNR}^i = \frac{\bar{w}^i}{\overline{CPI}^i(1 + \bar{\nu}^{c,i})}$$

and the definitions of parameters cy_i the shares of consumption in GDP, gives:

$$\hat{A}_{t-1}^1 = \beta\hat{A}_t^1 - \beta cy_1(1 + \bar{\nu}^{c,1})(\widehat{PPNR}_t^1 + \hat{L}_t^1 - \hat{c}_t^1) - \beta\hat{B}_t^1 \tag{2.107}$$

$$\hat{A}_{t-1}^2 = \beta\hat{A}_t^2 - \beta cy_2(1 + \bar{\nu}^{c,2})(\widehat{PPNR}_t^2 + \hat{L}_t^2 - \hat{c}_t^2) - \beta\hat{B}_t^2 \tag{2.108}$$

The law of motion of private assets thus depends on net revenue minus consumption.

Governments

Symmetrically, for the governments, we have:

$$\begin{aligned}
\hat{PA}^1_{t-1} &= \beta\widehat{PA}^1_t - \beta\Big((gy_1 - \bar{v}^{c,1}cy_1)(\widehat{PPNR}^1_t + \hat{L}^1_t + \hat{v}^{w,1}_t) + \\
&\qquad \bar{v}^{c,1}cy_1\hat{c}^1_t + (\bar{v}^{w,1}\bar{v}^{c,1} + \bar{v}^{c,1})cy_1\hat{v}^{c,1}_t - gy_1(\hat{G}^1_t - R\hat{P}C^1_t)\Big). \\
\hat{PA}^2_{t-1} &= \beta\hat{PA}^2_t - \beta\Big((gy_2 - \bar{v}^{c,2}cy_2)(\widehat{PPNR}^2_t + \hat{L}^2_t + \hat{v}^{w,2}_t) + \\
&\qquad \bar{v}^{c,12}cy_2\hat{c}^2_t + (\bar{v}^{w,2}\bar{v}^{c,2} + \bar{v}^{c,2})cy_2\hat{v}^{c,2}_t - gy_2(\hat{G}^2_t - R\hat{P}C^2_t)\Big)
\end{aligned} \tag{2.109}$$

Thus public wealth increases with wages, worked hours and consumption and it decreases with public spending or tax cuts.

2.3.4 Phillips Curves

Wages

From the previous section, we have:

$$0 = E_t\sum_{T_t}^{\infty}(\xi_w\beta)^{T-t}\tilde{L}^i(\tau,t,T)\left[\left(\left(\frac{\tilde{w}^i(\tau,t)\Lambda_t^{T-1}}{w^i_T}\right)^{-\theta^i_w}L^i_T - h^i_l L^i_t\right)^{\sigma^i_l}\right. \tag{2.110}$$

$$\left. - \lambda_T\frac{1-\theta^i_w}{\kappa\theta^i_w}\tilde{w}^i(\tau,t)\Lambda_t^{T-1}\right]. \tag{2.111}$$

This is linearised into:

$$\begin{aligned}
0 = &\sum_{T=t}^{\infty}(\beta\xi^i_w)^{T-t} \\
&\frac{-\theta^i_w\sigma^i_l}{1-h^i_l}\left(\delta\hat{\tilde{w}}_t + \widehat{PPNR}_t - \widehat{PPNR}_T + \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}(\hat{v}^{c,i}_t - \hat{v}^{c,i}_T) - \sum_{j=t+1}^{T}(\hat{\Pi}^{c,i}_j - \gamma^i_w\hat{\Pi}^{c,i}_{j-1})\right) \\
&+\frac{\sigma^i_l}{1-h^i_l}\left(\hat{L}^i_T - h^i_l\hat{L}^i_{T-1}\right) + \frac{\sigma^i_c}{1-h^i_c}\left(\hat{C}^i_t T - h^i_c\hat{C}^i_{T-1}\right) \\
&-\left(\delta\hat{\tilde{w}}_t + \widehat{PPNR}_t + \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}(\hat{v}^{c,i}_t - \hat{v}^{c,i}_T) - \sum_{j=t+1}^{T}(\hat{\Pi}^{c,i}_j - \gamma^i_w\hat{\Pi}^{c,i}_{j-1})\right),
\end{aligned} \tag{2.112}$$

(2.113)

which gives:

$$\begin{aligned}0 = &\sum_{T=t}^{\infty}(\beta\xi_w^i)^{T-t}\\ &+\frac{\sigma_l^i}{1-h_l^i}\left(\hat{L}_T^i - h_l^i\hat{L}_{T-1}^i\right)+\frac{\sigma_c^i}{1-h_c^i}\left(\hat{C}_T^i - h_c^i\hat{C}_{T-1}^i\right)\\ &+\frac{\theta_w^i\sigma_l^i}{1-h_l^i}\widehat{PPNR}_T+\left(\frac{\theta_w^i\sigma_l^i}{1-h_l^i}+1\right)\frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_T^{c,i}\\ &-\left(\frac{\theta_w^i\sigma_l^i}{1-h_l^i}+1\right)\left[\delta\hat{\tilde{w}}_t+\widehat{PPNR}_t+\frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_t^{c,i}-\sum_{j=t+1}^{T}(\hat{\Pi}_j^{c,i}-\gamma_w^i\hat{\Pi}_{j-1}^{c,i})\right].\end{aligned} \tag{2.114}$$

Differentiating between time t and time $t+1$ yields:

$$\begin{aligned}0 = &\frac{\sigma_l^i}{1-h_l^i}\left(\hat{L}_t^i - h_l^i\hat{L}_{t-1}^i\right)+\frac{\sigma_c^i}{1-h_c^i}\left(\hat{C}_t^i - h_c^i\hat{C}_{t-1}^i\right)\\ &+\frac{\theta_w^i\sigma_l^i}{1-h_l^i}\widehat{PPNR}_t+\left(\frac{\theta_w^i\sigma_l^i}{1-h_l^i}+1\right)\frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_t^{c,i}\\ &-\left(\frac{\theta_w^i\sigma_l^i}{1-h_l^i}+1\right)\frac{1}{1-\beta\xi_w^i}\left[\delta\hat{\tilde{w}}_t+\widehat{PPNR}_t+\frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_t^{c,i}\right]\\ &+\left(\frac{\theta_w^i\sigma_l^i}{1-h_l^i}+1\right)\frac{\beta\xi_w^i}{1-\beta\xi_w^i}\left[\delta\hat{\tilde{w}}_{t+1}+\widehat{PPNR}_{t+1}+\frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_{t+1}^{c,i}+\left(\hat{\Pi}_{t+1}^{c,i}-\gamma_w^i\hat{\Pi}_t^{c,i}\right)\right]\end{aligned} \tag{2.115}$$

$$\begin{aligned}0 = &\frac{\sigma_l^i}{1-h_l^i}\left(\hat{L}_t^i - h_l^i\hat{L}_{t-1}^i\right)+\frac{\sigma_c^i}{1-h_c^i}\left(\hat{C}_t^i - h_c^i\hat{C}_{t-1}^i\right)-\widehat{PPNR}_t\\ &+\left(\frac{\theta_w^i\sigma_l^i}{1-h_l^i}+1\right)\left[\widehat{PPNR}_t+\frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_t^{c,i}\right]\\ &-\left(\frac{\theta_w^i\sigma_l^i}{1-h_l^i}+1\right)\frac{1}{1-\beta\xi_w^i}\left[\delta\hat{\tilde{w}}_t+\widehat{PPNR}_t+\frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_t^{c,i}\right]\\ &+\left(\frac{\theta_w^i\sigma_l^i}{1-h_l^i}+1\right)\frac{\beta\xi_w^i}{1-\beta\xi_w^i}\left[\delta\hat{\tilde{w}}_{t+1}+\widehat{PPNR}_{t+1}+\frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_{t+1}^{c,i}+\left(\hat{\Pi}_{t+1}^{c,i}-\gamma_w^i\hat{\Pi}_t^{c,i}\right)\right],\end{aligned} \tag{2.116}$$

$$
\begin{aligned}
0 = & \frac{\sigma_l^i}{1-h_l^i}\left(\hat{L}_t^i - h_l^i \hat{L}_{t-1}^i\right) + \frac{\sigma_c^i}{1-h_c^i}\left(\hat{C}_t^i - h_c^i \hat{C}_{t-1}^i\right) - \widehat{PPNR}_t \\
& + \left(\frac{\theta_w^i \sigma_l^i}{1-h_l^i} + 1\right)\frac{1}{1-\beta\xi_w^i} \\
& (1-\beta\xi_w^i)\widehat{PPNR}_t + (1-\beta\xi_w^i)\frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_t^{c,i} - \delta\hat{\tilde{w}}_t - \widehat{PPNR}_t - \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_t^{c,i} \\
& + \beta\xi_w^i\left(\delta\hat{\tilde{w}}_{t+1} + \widehat{PPNR}_{t+1} + \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\hat{v}_{t+1}^{c,i} + \left(\hat{\Pi}_{t+1}^{c,i} - \gamma_w^i \hat{\Pi}_t^{c,i}\right)\right)
\end{aligned}
\tag{2.117}
$$

$$
\begin{aligned}
0 = & \frac{\sigma_l^i}{1-h_l^i}\left(\hat{L}_t^i - h_l^i \hat{L}_{t-1}^i\right) + \frac{\sigma_c^i}{1-h_c^i}\left(\hat{C}_t^i - h_c^i \hat{C}_{t-1}^i\right) - \widehat{PPNR}_t \\
& - \left(\frac{\theta_w^i \sigma_l^i}{1-h_l^i} + 1\right)\frac{1}{1-\beta\xi_w^i}\Big[\delta\hat{\tilde{w}}_t - \beta\xi_w^i\delta\hat{\tilde{w}}_{t+1} \\
& - \beta\xi_w^i\left(\widehat{PPNR}_{t+1} - \widehat{PPNR}_t + \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\left(\hat{v}_{t+1}^{c,i} - \hat{v}_t^{c,i}\right) + \left(\hat{\Pi}_{t+1}^{c,i} - \gamma_w^i \hat{\Pi}_t^{c,i}\right)\right)\Big].
\end{aligned}
\tag{2.118}
$$

And the Calvo process induces:

$$
0 = \xi_w^i\left(\widehat{PPNR}_{t-1}^i - \widehat{PPNR}_t^i - (\hat{\Pi}_t^{c,i} - \gamma_w^i \hat{\Pi}_{t-1}^{c,i}) - \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}(\hat{v}_t^{c,i} - \hat{v}_{t-1}^{c,i})\right) + (1-\xi_w^i)\delta\hat{\tilde{w}}_t^i \tag{2.119}
$$

$$
\delta\hat{\tilde{w}}_t^i = \frac{\xi_w^i}{1-\xi_w^i}\left(\widehat{PPNR}_t^i - \widehat{PPNR}_{t-1}^i + (\hat{\Pi}_t^{c,i} - \gamma_w^i \hat{\Pi}_{t-1}^{c,i}) + \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}(\hat{v}_t^{c,i} - \hat{v}_{t-1}^{c,i})\right). \tag{2.120}
$$

The Phillips curve for wages then reads:

$$
\begin{aligned}
& \widehat{PPNR}_t^i - \widehat{PPNR}_{t-1}^i + (\hat{\Pi}_t^{c,i} - \gamma_w^i \hat{\Pi}_{t-1}^{c,i}) + \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}(\hat{v}_t^{c,i} - \hat{v}_{t-1}^{c,i}) = \\
& \beta\left(\widehat{PPNR}_{t+1} - \widehat{PPNR}_t + \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}}\left(\hat{v}_{t+1}^{c,i} - \hat{v}_t^{c,i}\right) + \left(\hat{\Pi}_{t+1}^{c,i} - \gamma_w^i \hat{\Pi}_t^{c,i}\right)\right) \\
& + \frac{(1-\beta\xi_w^i)(1-\xi_w^i)}{\xi_w^i\left(\frac{\theta_w^i\sigma_l^i}{1-h_l^i}+1\right)}\left[\frac{\sigma_l^i}{1-h_l^i}\left(\hat{L}_t^i - h_l^i \hat{L}_{t-1}^i\right) + \frac{\sigma_c^i}{1-h_c^i}\left(\hat{C}_t^i - h_c^i \hat{C}_{t-1}^i\right) - \widehat{PPNR}_t\right].
\end{aligned}
\tag{2.121}
$$

So the level of inflation on wages hinges positively on future anticipated inflation, past inflation, taxes. The larger the discount factor β, the more sensitive is wage inflation to inflation expectations. The larger the probability to adjust prices $1-\xi^i$ (i.e. the more flexible are prices and wages), the less inflation depends on expectations. Inflation depends also positively on labour demand and consumption: households demand a higher wage to work more and consequently consume more.

Prices

From the maximisation of the firm's programme and the linearisation of the first-order conditions, we have:

$$\begin{aligned} 0 = & \sum_{T=t}^{\infty} (\beta\xi^i)^{T-t} \lambda_T^i \\ & \left((1-\theta^i)\Gamma_t^{T-1} \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{P_T^i} \right)^{-\theta^i} Y_T^i \right. \\ & \left. - \frac{\theta^i}{\alpha} \left(\frac{Y_T^i}{\zeta_t^i} \right)^{\frac{1}{\alpha}} \frac{1}{\tilde{P}^i(\varepsilon,t)} \left(\frac{\tilde{P}^i(\varepsilon,t)\Gamma_t^{T-1}}{P_T^i} \right)^{-\frac{\theta^i}{\alpha}} \right), \end{aligned} \tag{2.122}$$

We also know that $\tilde{P}^i(\varepsilon,t)$ is independent from ε since all firms solve the same program, and the Calvo process on prices yields:

$$\hat{\tilde{\Pi}}^i(\varepsilon,t) = \frac{\xi^i}{1-\xi^i} \left(\hat{\Pi}_t^i - \gamma_i \hat{\Pi}_{t-1}^i \right). \tag{2.123}$$

Plugging this in into the equation above, and differentiate between time t and time $t+1$, we obtain a standard linearised New-Keynesian Phillips curve for prices:

$$\begin{aligned} \hat{\Pi}_t^i - \gamma_i \hat{\Pi}_{t-1}^i = & \beta \left(\hat{\Pi}_{t+1}^i - \gamma_i \hat{\Pi}_t^i \right) + \frac{(1-\beta\xi^i)(1-\xi^i)}{\xi^i} \frac{\alpha}{\alpha+\theta_i(1-\alpha)} \\ & \left[\widehat{PPNR}_t^i + \widehat{RPC}_t^i + \frac{\bar{v}^{w,i}}{1+\bar{v}^{w,i}} \hat{v}_t^{w,i} + \frac{\bar{v}^{c,i}}{1+\bar{v}^{c,i}} \hat{v}_t^{c,i} - \frac{\hat{\zeta}_t^i}{\alpha} + (\frac{1}{\alpha}-1)\hat{Y}_t^i \right], \end{aligned} \tag{2.124}$$

where inflation depends positively on past indexed inflation, future anticipated inflation, relative prices and wages, taxes, total output in country i and negatively on productivity.

2.3.5 Monetary Policy, Relative Prices, Inflations

The linearised Taylor rule reads:

$$\hat{R}_t = \rho \hat{R}_{t-1} + (1-\rho)\left(\frac{r_\pi}{4}\sum_{i=t-3}^{t}\hat{P}i_i + r_y\hat{Y}_t\right), \tag{2.125}$$

where the weighted averages for inflation and output in the monetary union are:

$$\hat{P}i_t^c = \frac{\theta}{1+\theta}\hat{\Pi}_t^{c,1}\frac{1+\nu_t^{c,i}}{1+\nu_{t-1}^{c,i}} + \frac{1}{1+\theta}\hat{\Pi}_t^{c,2}\frac{1+\nu_t^{c,i}}{1+\nu_{t-1}^{c,i}}, \tag{2.126}$$

$$\hat{Y}_t = \frac{\theta}{1+\theta}\hat{Y}_t^1 + \frac{1}{1+\theta}\hat{Y}_t^2. \tag{2.127}$$

By the definition of relative prices

$$\frac{P_t}{P_{t-1}} = \frac{CPI_{t-1}}{P_{t-1}}\frac{P_t}{CPI_t}\frac{CPI_t}{CPI_{t-1}},$$

we get:

$$\hat{\Pi}_t^1 = \widehat{RPC}_{t-1}^1 - \widehat{RPC}_t^1 + \hat{\Pi}_t^{c,1} \tag{2.128}$$

$$\hat{\Pi}_t^2 = \widehat{RPC}_{t-1}^2 - \widehat{RPC}_t^2 + \hat{\Pi}_t^{c,2}. \tag{2.129}$$

And the terms of trade depend on inflation differentials between countries:

$$\hat{T}_t = \hat{T}_{t-1} + \hat{\Pi}_t^2 - \hat{\Pi}_t^1. \tag{2.130}$$

2.3.6 Model Sequence

We can sum up the sequence of decisions of our model with the help of Figure 2.2. At the beginning of the period, shocks occur. Then, all agents interact on the different markets: the central bank chooses the interest rate, households and governments choose their consumption and firms set their production and agree on wages and labour supply with households. Finally, firms pay dividends from their profits. Households and governments are left with their end-of-period asset holdings, for which they will pay or receive an interest rate in the next period (minus intermediation costs).

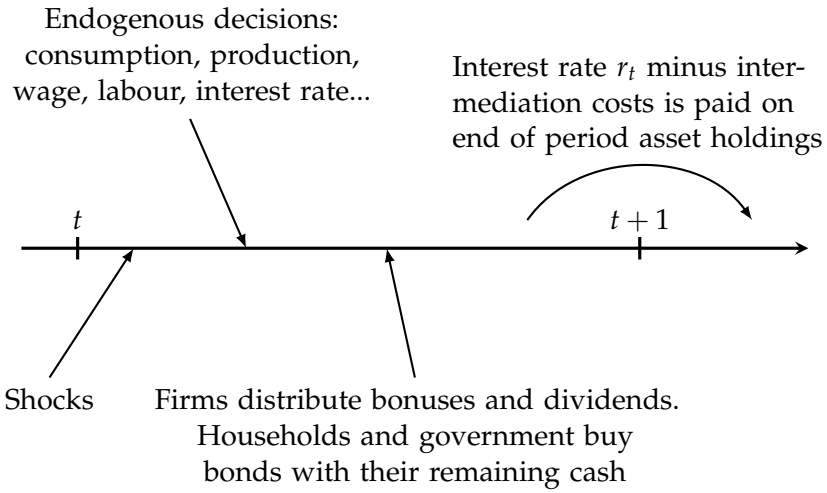


Figure 2.2: Model sequence

2.4 Parameters Calibration

We calibrate the model as follows:

Parameter	Description	Value
α	Production technology parameter	0.7
β	Discount factor	0.99
h_c^1, h_c^1	Habit formation on consumption	0.7
h_g^1, h_g^2	Habit formation on public expenditure	0.7
h_l^1, h_l^2	Habit formation on labour	0.7
σ_c^1, σ_c^2	Inverse of intertemporal elasticity of substitution of private consumption	1
σ_l^1, σ_l^2	Inverse of the Frisch elasticity	2
σ_g^1, σ_g^2	Inverse of intertemporal elasticity of substitution of public expenditure	1
κ	Weight of labour in utility	see Model
α_1, α_2	Import share	0.45
ξ_1, ξ_2	Calvo parameter on prices and wages adjustment	0.75
γ_1, γ_2	Price and wage indexation on past inflation	0.2
θ_1, θ_2	Elast. of sub. of domestic products and labour yielding a markup of 20% on prices and wages	6
ψ_1, ψ_2	Financial premium on household debt	0.05
ψ_1^g, ψ_2^g	Financial premium on government debt	0.05
$\bar{\nu}^{c,1}, \bar{\nu}^{c,2}$	Tax level on consumption	20%
$\bar{\nu}^{w,1}, \bar{\nu}^{w,2}$	Tax level on wages	19%
r_π	Central Bank reaction to inflation	1.7
ρ	Taylor rule smoothing parameter	0.8
r_y	Central Bank reaction to output gap	0.25
θ	Economic size ratio $\bar{Y}^1/\bar{Y}^2$	1
$\bar{C}^1/\bar{Y}^1 = cy_1$,	Relative shares of private consumption in GDP	0.7
$\bar{C}^2/\bar{Y}^2 = cy_2$		0.7
$\bar{G}^1/\bar{Y}^1 = gy_1$,	Relative shares of government spending in GDP	$1 - cy1$
$\bar{G}^2/\bar{Y}^2 = gy_2$		$1 - cy2$

Table 2.1: Parameters calibration

Our calibration of some classical parameters such as the discount factor, habit formation, monetary policy and elasticities of substitution (between goods θ, between periods σ_c, σ_g or inverses of the Frisch elasticities σ_l), are usual eurozone quarterly estimates (as in Smets and Wouters (2003) or Ratto, Roeger, and Int'Veld (2009) and the European Commission QUEST Estimates (2001)). For the habit parameters on private consumption, labour and government consumption, we chose to follow Darracq Pares, Adjemian, and Moyen (2007) and set them all at 0.7.

The value of the inverse intertemporal elasticity of substitution of private consumption in the CES utility functions of households, σ_c, determines the prevalence of the substitution or income effect and so how tax cuts impact on output and consumption. We set $\sigma_c = 1$, so that the wealth and substitution effects neutralise one another, and so biased

results regarding the relative effectiveness of different fiscal policies are avoided. (In the next chapter, we discuss alternative values for σ_c and the differences they lead to in terms of policy and spillover effects.)

The value of σ_l (set at 2 as in Corsetti, Meier, and Müller (2010)), the inverse of the Frisch elasticity of the labour supply, captures the sensitivity of agents to changes in their labour supply and wages and also has an impact on the discrepancies observed in the effects of fiscal policy in different monetary-union configurations (detailed in the next chapter).

Parameter α_i denotes the import share of private consumption (and, indirectly, the degree of openness of both economies) and is calibrated at 0.45 on averages of openness ratios (exports and imports as a share of GDP) in the eurozone.

The economic size ratio is captured by θ. In the baseline scenario, countries are supposedly symmetric, so $\theta = 1$.

Price rigidities are captured by ξ_i, the Calvo parameter. This is linked to the average duration of contracts through $E(duration) = 1/(1-\xi_i)$. In line with the values commonly found in the literature (which assign contract durations from nine months to a year and a half), we choose $\xi_i = 0.75$. This value yields a price contract duration of one year.

The two tax rates in both countries are linked to each other to ensure the budget constraint of governments at the steady state. We have chosen a tax level on consumption of 20%, which corresponds to the average (normal) VAT rate in the European Union in 2010.[7] The payroll tax level derived from this choice is also approximately 20% in the baseline calibration.

Due to the structure of our model, once the share of private consumption in GDP – cy_i – for one country has been chosen (matching actual eurozone averages), other ratios $\frac{\bar{C}^2}{\bar{Y}^2}$ or cy_2, $\frac{\bar{G}^1}{\bar{Y}^1}$ or gy_1 and $\frac{\bar{G}^2}{\bar{Y}^2}$ or gy_2 are determined by the relationship $\frac{cy_1}{cy_2} = \frac{\alpha_2}{\alpha_1\theta}$ and the fact that $cy_1 + gy_2 = cy_1 + gy_2 = 1$, i.e. in each country the share of private and public consumption in GDP add up to one.

Parameters ψ_i and ψ_i^g capture the reaction of financial markets to an increase in debt or asset holdings of households and governments, respectively. For instance, with our calibration, if households increase their debt (respectively asset holding) by 1% of their country's GDP, the financial intermediary will apply a spread 5 basis points higher (resp. lower) on this contract. Our calibration of the elasticity of the bond spread to public (or private) debt roughly replicates the relative volatility of the debt-to-GDP ratio and

[7] As of 2011, VAT rates in the euro-area are ranged from 15% in Luxemburg in to 23% in Finland and Portugal.

the spread of the 10-year government bond with that of Germany. Indeed, the standard deviation of debt-to-GDP ratio fluctuations in the eurozone between 1999 and 2007 equals 2.85 (source: Eurostat), while that of variations of the spread with the German 10-year bond is 0.64. The ratio of the two is 0.22 on a yearly basis, so we use 0.05 for our quarterly calibration.

With the exception of σ_c and σ_l (as explained in the following chapter), our results do not crucially hinge on the calibration. For example, we could set the habit formations (h, h^l, h^g) and price and wage indexation (γ_i) at 0 and use constant returns to scale production functions and our model would exhibit features similar to the ones detailed subsequently.

2.5 Objective Function for Expenditure versus Government Spending Rules

In an attempt to replicate discretionary fiscal policy making in the monetary union, the features of the government block depart from standard modelling.(That is, governments maximise an objective function increasing in the public expenditure level subject to the government budget constraint, and taxes are assumed to be exogenous.) Comparing the effects of fiscal policies with other models is therefore difficult, if not impossible. To check that this will not lead to spurious results, we compare fiscal variables' responses to shocks in our model to those in a model with a government spending rule such as in Corsetti, Meier, and Müller (2010). Their spending rule reads as follows:

$$\hat{G}_t^i = \psi_g \hat{G}_{t-1}^i + \psi_y \hat{Y}_{t-1}^i + \psi_d \frac{PA_t^i}{P_{t-1}^i \bar{Y}^i} + \varepsilon_t, \tag{2.131}$$

where ψ_g, ψ_y, ψ_d denote respectively the responsiveness of government spending to the past level of government spending, to the output gap and to public asset holdings.

We set $\psi_g = 0.7$ to be equal to the external habit formation parameter on government spending from our model. Corsetti, Meier, and Müller's calibration does not always fulfil the rank condition with our model, in which tax rates are constant and not lump-sum. We had to increase the sensitivity of public expenditure to public assets to compensate for the fact that the tax level does not increase with public assets ($\psi_y = +0.15$ instead of 0.02).

In Figure 2.3, we plot the impulse response functions (IRF) of government spending and government asset holdings in country 1 in reaction to the following usual shocks:

(i) a positive 1% monetary policy shock;

(ii) a positive 1% productivity shock;

(iii) a 1% intertemporal preference shock i.e. a 1% shock on β, the discount factor affecting households' Euler equations.

And also in reaction to the following fiscal policy shocks:

(iv) a 1% increase in government spending;

(v) a 1-point cut in the VAT;

(vi) a 1-point cut in the payroll tax.

The different curves represent the following modelling options for fiscal behaviour of the government:

- government spending defined by our Euler equation without external habit formation,
- government spending defined by our Euler equation with external habit formation,
- government spending following the rule suggested by Corsetti, Meier, and Müller (procyclical, $\psi_y = +0.04$),
- government spending following the rule suggested by Corsetti, Meier, and Müller (contracyclical, $\psi_y = -0.04$),
- government spending following the rule suggested by Corsetti, Meier, and Müller with increased sensitivity (procyclical, $\psi_y = +0.2$),
- government spending following the rule suggested by Corsetti, Meier, and Müller with increased sensitivity (contracyclical, $\psi_y = -0.2$).

We find that the responses to the different shocks in the economy are quite similar across models – except for the effect of monetary policy shocks on asset holdings. As expected, habit formation induces more stickiness in the government's reactions, and higher sensitivity in the budget rule increases the magnitude of these reactions.

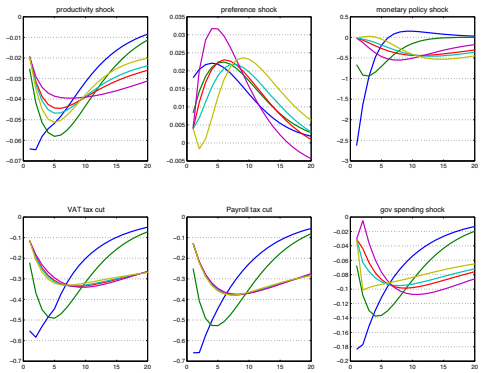
Counter-intuitively, setting a procyclical or a contracyclical spending rule does not induce much change in the government's reactions to various shocks. The difference is

only noticeable when procyclicality (or contracyclicality) is enhanced in the reaction of public expenditure to a shock on preferences or government spending.

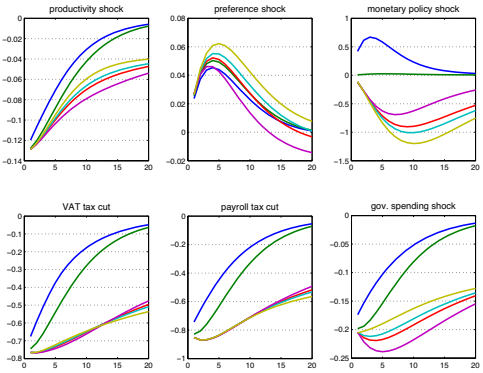
With our government spending model, public expenditures are slightly more impacted by fiscal stimuli shocks, and public asset holdings recover from the expansionary policy more quickly. Thanks to external habit formation, the magnitude of the fiscal policy effect is very similar under the different spending rules. Under the spending rule of Corsetti, Meier, and Müller, government spending and assets tend to be more persistent, but using a smaller premium on public assets with our specification of public expenditure tends to increase the persistence of the government's reactions, which are then closer to those with Corsetti, Meier, and Müller's rules.

With our specification, we observe an increase in public assets in reaction to a positive monetary policy shock. Indeed, as interest rates rise, governments will try to issue less debt. Corsetti, Meier, and Müller's approach and ours differ on this. We deem this reaction of sovereign debt to an increase in interest rates to be relevant, especially in the eurozone, where governments cannot monetise their debt. We thus contend that our modelling approach of the fiscal authority better matches currency-union features.

Government spending IRFs in country 1



Public assets IRFs in country 1



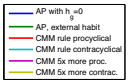


Figure 2.3: Comparing government spending rules

2.6 Model Dynamics and Fiscal Policy: From a Closed Economy to a Monetary Union

This section is devoted to the analysis of the model dynamics with the help of impulse response functions in a closed-economy setting and in a symmetric monetary union. The simulations for the closed economy provide a benchmark or control experiment against which the effect of openness, fiscal spillovers and the common monetary policy can be assessed for the two-country setting.

We generate the following traditional shocks in the closed economy and country 1 of the monetary union:

(i) a positive 1% monetary policy shock;

(ii) a positive 1% productivity shock;

(iii) a 1% intertemporal preference shock i.e. a 1% shock on β, the discount factor affecting households' Euler equations.

Additionally, we compute the IRFs to three fiscal policy shocks:

(iv) a 1% increase in government spending;

(v) a 1-point cut in the VAT;

(vi) a 1-point cut in the payroll tax.

All shocks have an autocorrelation factor $\phi = 0.75$. Responses are expressed in percentage deviations from steady-state values.

2.6.1 The Closed-Economy Case

Economic shocks in a closed economy

Figure 2.4 displays impulse response functions of economic variables following 1% monetary, preference and productivity shocks in a closed one-country model. The model allows for a strong transmission channel of monetary policy onto the the rest of the system. Indeed, the monetary shock has a strong depressive effect on the economy, with output and consumption down 3% at the trough of the curve. CPI inflation is driven down and so is government spending as the raise in the interest rates makes debt dearer. The effects of the other shocks are more subdued. The productivity shock has mainly a

positive impact on dividends and so on households' assets, other economic variables do not react strongly because the increase in productivity translates into more leisure and not more labour supply from the households. Likewise, the preference shock only changes slightly the dynamics of assets that is dependent on intertemporal discounting and the rest of the system is left mainly unchanged.

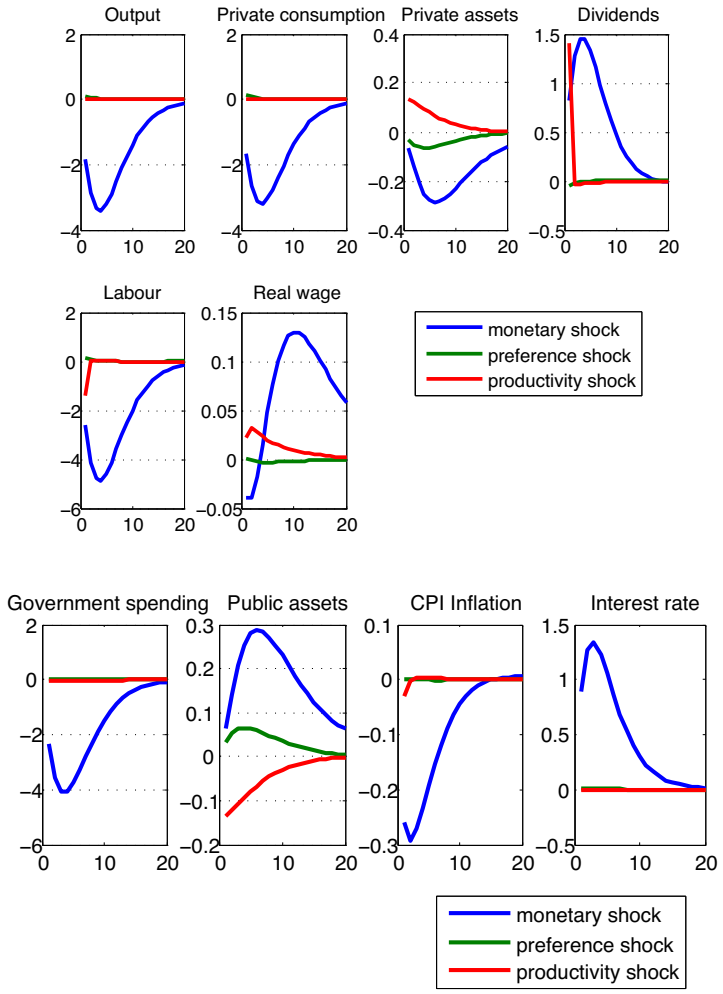


Figure 2.4: IRFs after 1% monetary, preference and productivity shocks in a closed economy

Policy shocks in a closed economy

The increase in government spending are as much purchases directed at home production, driving output (+1%) and labour up (hours worked follow the evolution of output because there is no productive capital in the model). The crowding-out effect on home consumption (only +0.15%) that cannot be fully compensated by imports. Households save their additional income. Inflation is kept under check by the response of the central bank. Finally, following this rise in government expenditure, the evolution of public assets reflects the implicit debt limit enforced by the premium on debt. The effects of tax cuts are less strong on output (+0.1% for the VAT cut) and labour because mediated through prices and wages. Because of the deflationary impact on prices (directly for the VAT and through second-round effects for the payroll tax), the positive reaction of consumption is substantial, especially for the VAT cut (+0.6%). The smaller tax intake has to be made up by the government which decreases its spending and assets.

In a closed-economy setting, government spending proves most efficient in spurring output, and expectedly a VAT cut yields the largest increase in private consumption. These results are consistent with the empirical analysis of Monacelli, Perotti, and Trigari (2010). Relying on a VAR model, they find that a 1% spending shock is on average associated with a 1% increase in GDP in EU countries, and a 1% tax cut generates a response of +0.2 percentage points of steady-state output. They also corroborate the small effect of government spending on inflation, as the latter increases only by 0.02% after a positive government spending shock.

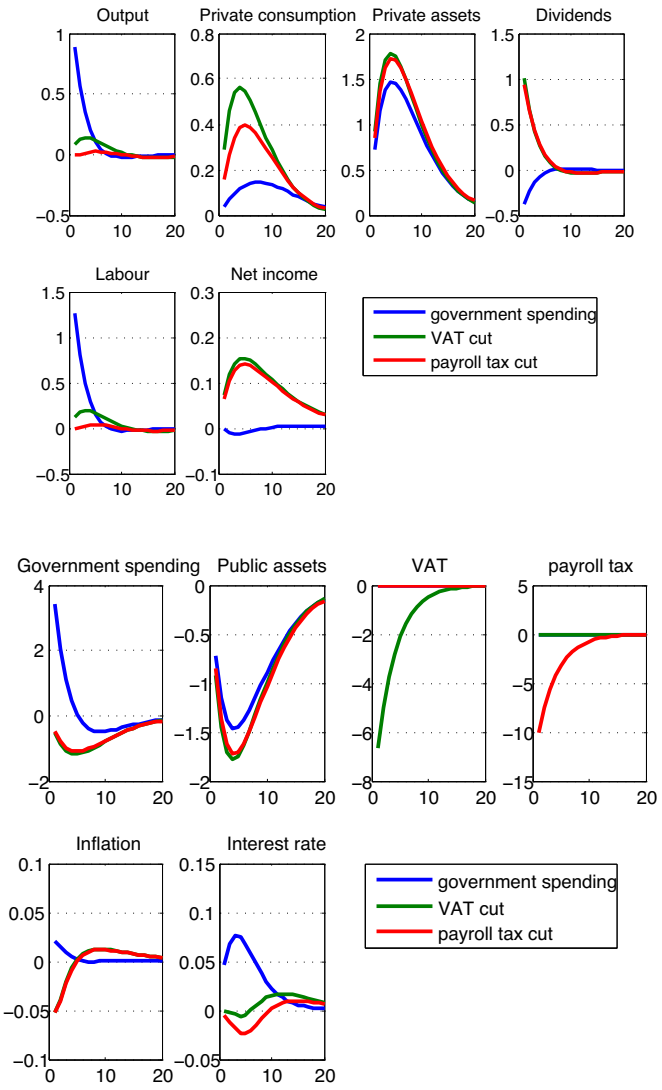


Figure 2.5: IRFs after 1% policy shocks in a closed economy

2.6.2 The Monetary-Union Case

Economic shocks in a monetary union

In the case of a monetary policy shock (see Figure 2.6), symmetric countries are impacted in the same way, so the trade channel is not relevant in this case. The interest-rate hike has a very strong adverse effect on outputs, consumption and public spending. Accordingly, CPI inflation is lowered. As firms sell at a lower price, they hire fewer workers, and employment plummets.

A positive productivity shock in country 1 (see Figure 2.7) drives output, labour and consumption up and eases fiscal consolidation as tax revenues soar. These expansionary effects are muted by the fact that firms hire less as wages increase and consequently, households save more. This shock adversely affects country 2 in terms of output as it loses market share to its more price-competitive neighbour. The reaction of the central bank is accommodative: as the union-wide CPI inflation decreases, so does the interest rate, fuelling overheating in country 1 but allowing the economy in country 2 to bounce back a little faster. To this extent, the central bank restores the economic balance between countries in the monetary union.

A positive preference shock in country 1 (see Figure 2.8) has the larger spillover effects as output levels in both countries are equally affected (+0.2% at the peak). However, the dynamics of the other variables differ; while the consumption boom is short-lived in country 1, it is protracted in country 2, where consumers have not changed their discount factor. More precisely, in country 1, households are less patient and increase their present consumption of domestic and foreign products. As a consequence, labour demands increase in both countries, and because wages do not decrease in country 2, households experience an increase in their disposable income and also consume more. Finally, higher consumption and labour supply translate into a larger tax intake, which finances the increases in public spending and assets.

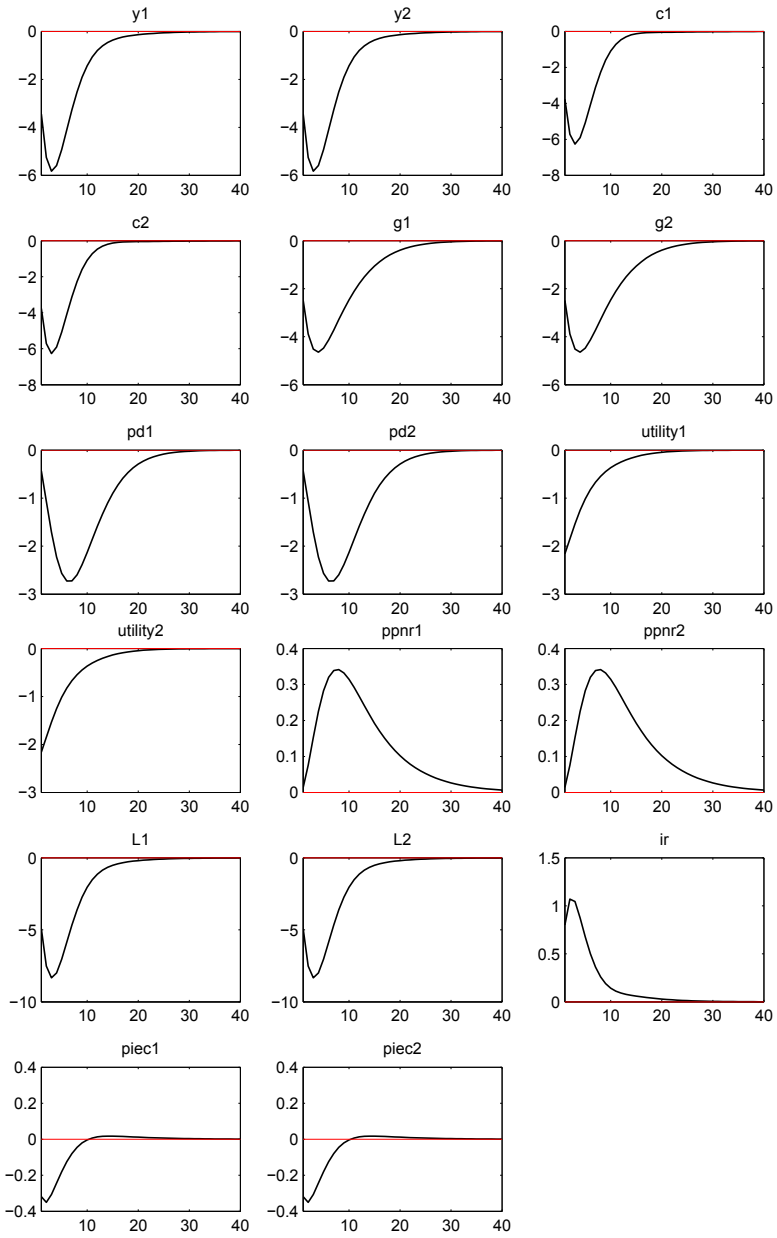


Figure 2.6: IRFs after a 1% monetary shock in the union

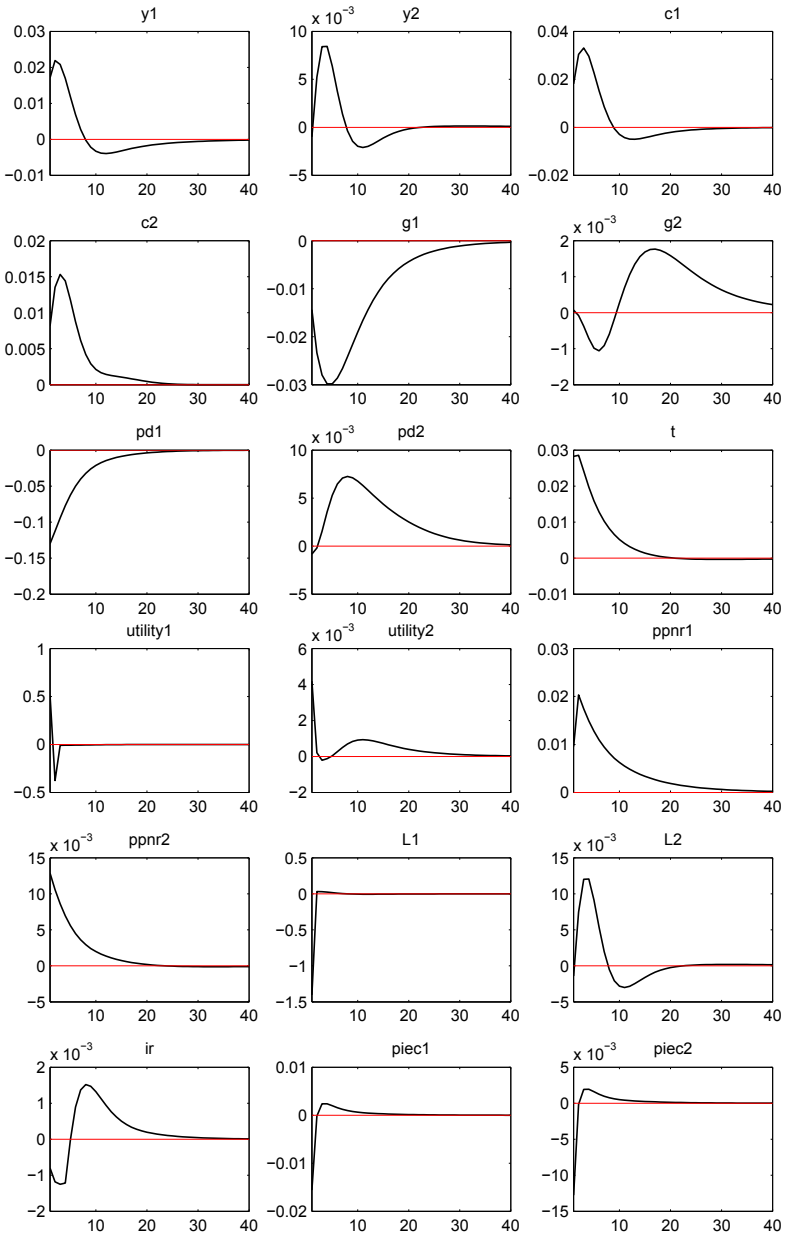


Figure 2.7: IRFs after a 1% productivity shock in country 1

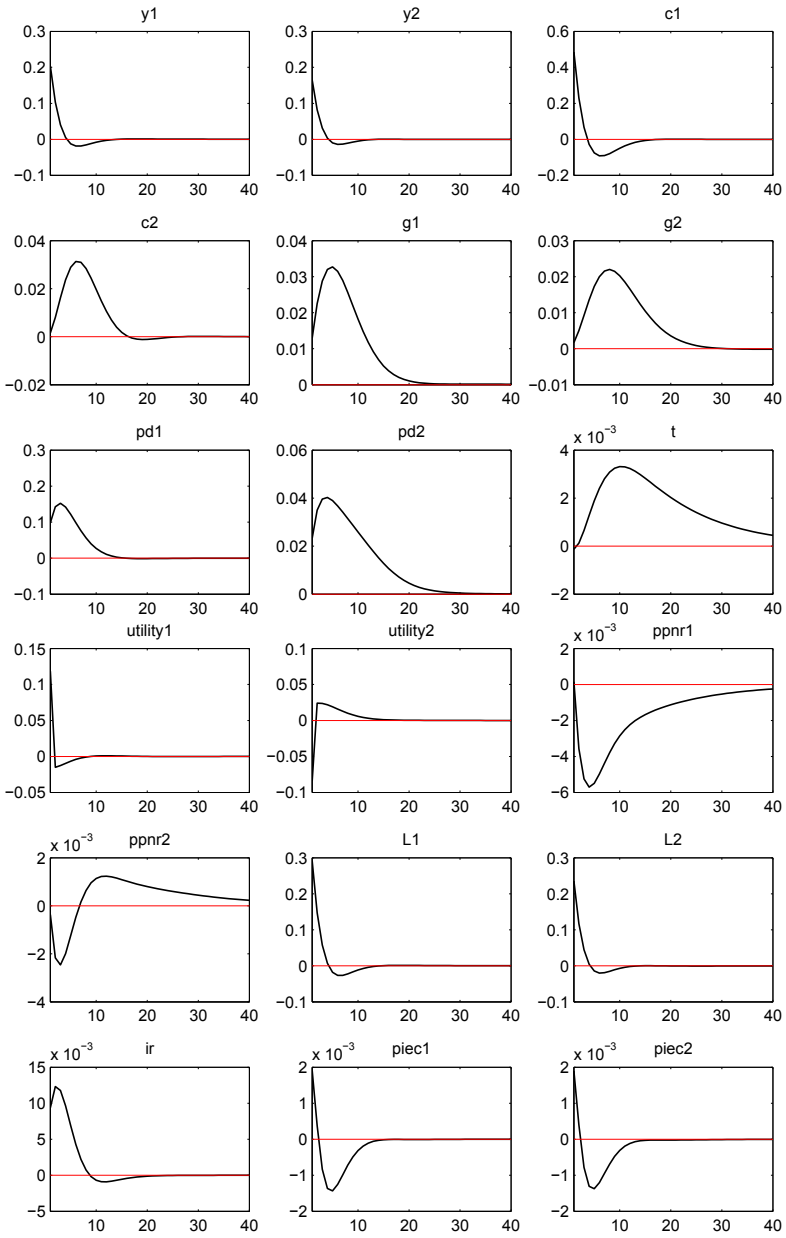


Figure 2.8: IRFs after a 1% preference shock in country 1

Fiscal policy shocks in a monetary union

Figure 2.9 and 2.10 compare the impulse response functions of key selected variables to a 1% increase in government expenditure, a one-point cut in the VAT and a one-point cut in the payroll tax in country 1. While agents are forward-looking and anticipate the dynamics of government spending, there are no anticipations regarding the future level of taxes so that the Ricardian effect is not at play: output and consumption in country 1 are positively affected by the shock (+0.8% and +0.2% respectively). As in the closed economy case, the rise in government expenditure boosts domestic output and labour, but crowds out domestic consumption which switches in part to imports (depending on the openness degree α_i). The increase in aggregate demand pushes domestic prices relative to foreign ones, so that there is a small terms-of-trade advantage to country 2. The central bank reacts to the evolutions of union output and CPI inflation by slightly raising the interest rate. To a lesser degree, output also rises in country 2, showing the existence of positive fiscal spillovers in the context of a monetary union. The leakages onto the foreign country remain small (+0.05% of steady-state deviation for output) because the expansion in country 1 is affected by country 2's reaction only through second-round effects; the increase in the interest rate has a depressive effect on the foreign country; and as put forward by Faia, Lechthaler, and Merkl (2010) in a currency union there is no exchange rate channel so adjustments through relative prices and wages are smaller than in a classical open-economy framework.

Impulse response functions of output and consumption variables to cuts in VAT and in the payroll tax exhibit the same patterns. In contrast to an increase in government spending, tax cuts have a more muted effect on the output of the domestic country (+0.2% after the VAT cut) and foster that of the foreign country through relative prices and wages (+0.25% on foreign GDP following the VAT cut). (As discussed in the calibration section, this ordering largely depends on the value of σ_c, the intertemporal elasticity of substitution.) Consumptions are pushed up by +0.4-+0.6% because of lower relative prices. Contrary to a pure fiscal expansion that triggers changes in quantities produced and consumed, adjustments now are largely nominal. The deterioration of the terms of trade proves stronger when the government lowers taxes because of the additional nominal effect.

Also, by decreasing tax levels, the government generates disinflation, which in turn affects the consumption-leisure trade-off. As labour costs are reduced by a cut in the payroll tax in country 1, country 2 imports more and contributes to demand-pull inflation

that drives prices and wages back up. The second-round effects of the tax cut do not stimulate production (captured by labour).

Public spending and tax cuts also have a differentiated effect on government variables. Because of the smaller tax intake, the domestic government lowers its expenditure level to meet its budget constraint, while the foreign country enjoys larger tax intake (through the consumption and labour) and can afford to increase its spending. The fiscal basis for the VAT cut represents 75% of GDP (consumption at the steady state), whereas that of the payroll tax is 100% (total revenue equals total output, which is total wages at the steady state). This explains the stronger adjustment of public assets, government spending and of the interest rate after a cut in the payroll tax. Likewise the downward adjustment of the interest rate to the deflationary pressures of the tax cuts is larger in the case of the payroll tax.

We can briefly assess the effect of openness on fiscal policy. Openness to international trade generates leakages: home output increases by 0.2% less after a positive 1% government spending shock than in a closed-economy. That does not hold for consumption as imports compensate for crowding-out by the government. The effects of tax cuts on home output and consumption are slightly larger than in the closed-economy case because of the competitive edge in terms of prices they give to the country. The foreign country's output benefits also from the tax cuts (up to 0.25%) through higher addressed demand but not so much from government spending (+0.05%). Openness thus preserves the ordering – if not the magnitude – of fiscal policies' impact on home output, but it introduces a strategic asymmetry between the country implementing fiscal policies and its trade partner. We will delve deeper into the analysis of these spillovers in the next chapter.

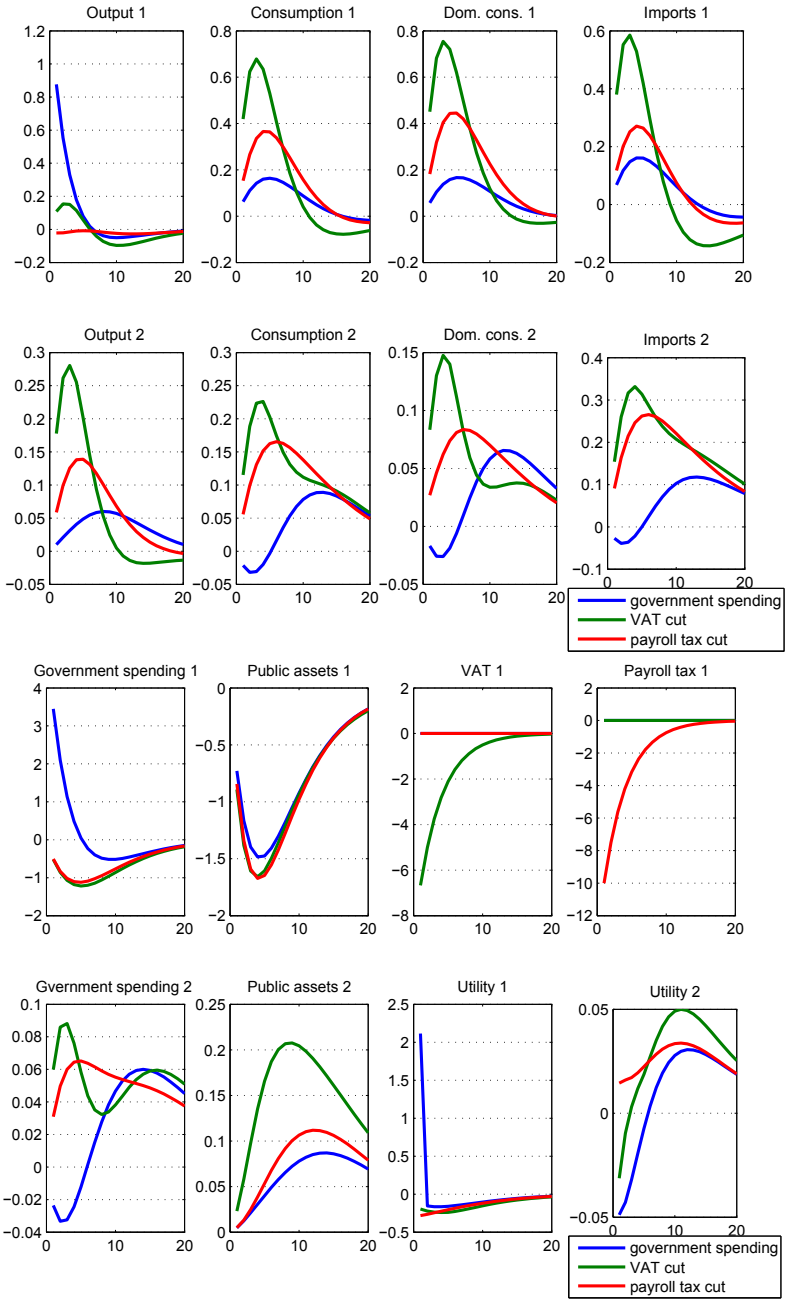


Figure 2.9: Policy shocks in a monetary union – 1 of 2

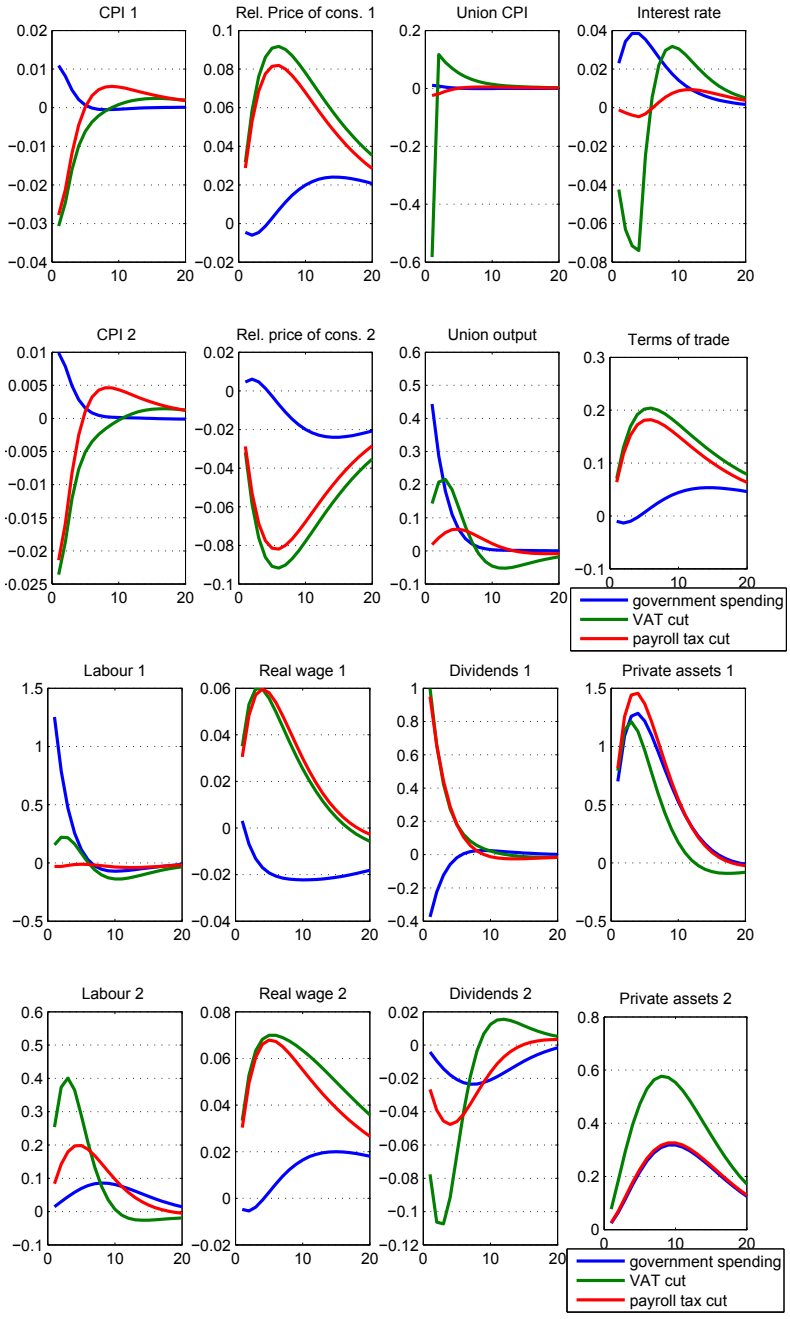


Figure 2.10: Policy shocks in a monetary union – 2 of 2

Comparison of fiscal multipliers with relevant studies

Empirical studies usually highlight a short-term positive effect of an increase in government spending on output but there is no consensus on the size of the fiscal multipliers. Our simulation results for government spending and tax cuts are in the same order of magnitude than those presented by Kumhof, Muir, Freedman, Mursula, Erceg, Furceri, Lalonde, Lindé, Mourougane, Roberts, Snudden, Trabandt, Coenen, Laxton, deResende, Roeger, and intVeld (2010). Mountford and Uhlig (2009) found for the US, that a 1% deficit spending has an effect on output ranged between +0.6% and 1.4%, but contrary to us they find a higher effect of tax cuts, between 2% and 5%. Christiano, Eichenbaum, and Rebelo (2009) show that the fiscal multiplier effect is large when the interest rate does not respond to increases in government spending. In our model, however, interest rates do respond because, in a monetary union, higher levels of public spending generate inflationary pressures. Regarding the effect of fiscal policies on consumption, Mountford and Uhlig (2009) or Cwik and Wieland (2009) find almost no reaction to deficit spending because of fiscal expansions' crowding-out effects and the anticipation of tax increases. While our theoretical model predicts also a crowding out effect, there is no anticipation of future tax increases.

Conclusion

This chapter detailed the construction of a micro-founded two-country monetary union model apt to show the effects of different fiscal policies with cross-country heterogeneities in terms of size and openness. The model is built such that the relative size and openness of countries impact on trade flows and monetary policy as the central bank considers union-wide output and inflation to set the interest rate. The fiscal authority block departs from traditional New-Keynesian modelling so as to better replicate real policy-making in times of crisis in heterogeneous countries of a monetary union. Governments maximise an objective function increasing in their expenditure level under their budget constraint. Under rational expectations, agents anticipate the normal behaviour or spending of the government, but do not anticipate one-off fiscal stimulus measures.

Since the criteria of the Stability of Growth Pact were seldom respected for a protracted period by EMU Member States, there is no strict fiscal rule but rather a "loose" limit on deficit and debt. This limit is enforced by a debt premium on private and public assets, that makes the cost of debt rise with the level of indebtedness and also ensures the stationarity of the model. A unique equilibrium is pinned down by clearing the position of the financial intermediary towards the central bank at each period.

Impulse response functions put forward the transmission mechanisms at play in the model and the effects of fiscal policy. First, in a closed economy setting, there are no leakages, explaining the larger fiscal multiplier of fiscal measures. The multiplier is higher in the case of government spending than for tax cuts as first-round effects on demand are immediate while the effects of tax cuts are mediated through price adjustments. Second, in a two-country setting, increased government spending proves more efficient in spurring domestic output than consumption or payroll-tax cuts. As public consumption is addressed solely to domestic production, increasing government spending has an immediate one-for-one effect on domestic output. Government spending generates a crowding-out effect and leads to volume adjustments of consumption towards imports, whereas tax cuts have a stronger nominal effect on relative price competitiveness. So with tax cuts, competition in prices and trade across countries mitigate the effects of fiscal stimuli.

The analysis of fiscal policy effects in a monetary union is furthered in the next chapter. The model developed is used to run fiscal policy simulations starting from a recession scenario, with particular emphasis on fiscal spillovers between different-sized countries.

3 Country Size Matters: Fiscal Policy in Times of Crisis and Spillovers in the EMU

with Aurélien Poissonnier

Abstract

Using a two-country micro-founded model of a monetary union with debt (detailed in the previous chapter) and allowing for cross-country heterogeneities in terms of size, openness and nominal rigidities, we simulate an increase in government spending as well as tax cuts in response to a crisis and comparatively assess their effectiveness. We find that increasing government spending is more effective in spurring output compared to tax cuts on consumption or on the payroll. We also detail the cross-border spillovers in a monetary union of these policies and explain how they depend on asymmetries between countries. We find that countries always benefit from their partner's fiscal stimuli (increase in public spending or tax cuts), especially small open ones. We put forward a strategic asymmetry: the home (or policy-making) country benefits more from an increase in public spending in terms of output and consumption, but its partner benefits from larger positive spillover effects in the case of tax cuts. Finally, we determine that in a monetary union "internal devaluation" is a less expansionary supply-side policy response to a crisis than increased public spending and it bears externalities on foreign public debt (+0.5% of induced debt than for other measures on average).

Introduction

The financial crisis of 2008-9 and in its wake, the eurozone sovereign debt crisis unfolding in 2010-11 have revived research on fiscal policies, their effects and costs, and exit strategies out of pricey stimulus packages. Indeed, governments of the eurozone face contradictory policy pressures. On the one hand, large-scope stimulus packages that were implemented to buoy up consumption and growth cannot be phased out too quickly lest

it triggers a double-dip recession. On the other hand, guaranteeing affordable sovereign financing with a common currency requires reigning in public finances (or deleveraging) and abiding by the debt and deficit limits set in the Stability and Growth Pact (SGP).

In this paper, we focus on different fiscal measures –increase in public spending or tax cuts on consumption or on the payroll –, their short-term domestic impact and spillover effects onto other monetary-union members. We rely on the Neo-Keynesian model detailed in the previous chapter, linearised around its steady-state to simulate fiscal stimuli after a crisis. Allowing now for asymmetries between countries in terms of size, openness and price rigidities, we see how these discrepancies affect the within- and cross-country fiscal spillovers.

From a union-wide perspective, we find that countries always benefit from their partner's fiscal stimulus (be it an increase in public spending or tax cuts). These positive spillovers are larger in the case of a cut in the consumption tax. We will see however that such a policy – because of its deflationary effects – may be problematic for the stance of the central bank if the interest rate is already close to the zero-lower-bound. We will also detail how spillovers depend on country size, openness and price rigidities. Finally, we determine that an "internal devaluation" policy is less effective than increased public spending as a recovery policy response to a crisis in a monetary union and, moreover, is detrimental to foreign public finances.

As regards the impact of heterogeneity between countries, the spillovers are greater for a small open country, and to a lesser extent, dependent on price rigidities. For example, when a larger country increases its public spending, the smaller one benefits more from the crowding-out effect in the large country. Or when the large country lowers its tax level, the pressure on the central bank to lower the interest rate is larger, and the small country benefits from a lower real interest rate. Additionally, if prices and wages are more flexible, the small country can compete in prices with its partner and reap greater benefits from the foreign tax cut.

Finally we find that "internal devaluation" may be a viable policy to regain competitiveness while keeping public financing in check for small and open economies but may also bear negative externalities for their neighbours' public finances.

The paper is organised as follows. In Section 1, we present a simplified version of the two-country monetary union model previously developed. We run deterministic simulations of different fiscal shocks (after a simulated crisis) and explain their effects in Section 2. Section 3 is devoted to the analysis of cross-border spillovers in an asymmetric

monetary union. In Section 4, we assess whether "internal devaluation" is a viable exit strategy for monetary-union members in crisis before concluding with our main findings.

3.1 Model

For the sake of clarity, we expound here a simplified version of our micro-founded monetary-union model. The augmented model and its linearisation are detailed in the previous chapter.[1] [2]

3.1.1 Goods Aggregation

Aggregation of production within countries

We assume that a continuum of goods of size one is produced in the monetary union. Goods in [0, n] are produced in country 1, while goods in] n, 1] are produced in country 2, where 0 <n< 1. In each country, domestic production is aggregated into a domestic good using a Dixit–Stiglitz aggregator with an elasticity of substitution specific to each country. These hypotheses yield the following relationship between the demand for goods produced by firm (ε, i) and the total demand for production of country i $(Y_t^i)_{i=\{1,2\}}$:

$$Y_t^1 = \left(\int_0^n y^1(\varepsilon, t)^{\frac{\theta_1 - 1}{\theta_1}} d\varepsilon \right)^{\frac{\theta_1}{\theta_1 - 1}}, \tag{3.1}$$

$$Y_t^2 = \left(\int_n^1 y^2(\varepsilon, t)^{\frac{\theta_2 - 1}{\theta_2}} d\varepsilon \right)^{\frac{\theta_2}{\theta_2 - 1}}. \tag{3.2}$$

where θ_i is the elasticity of substitution of goods in country i.

The corresponding production price indices are:

$$P_t^1 = \left(\int_0^n P^1(\varepsilon, t)^{1-\theta_1} d\varepsilon \right)^{\frac{1}{1-\theta_1}}, \tag{3.3}$$

$$P_t^2 = \left(\int_n^1 P^2(\varepsilon, t)^{1-\theta_2} d\varepsilon \right)^{\frac{1}{1-\theta_2}}. \tag{3.4}$$

[1] The augmented version of the model includes CES utility functions on private and public consumptions, a convex disutility of labour, external habit formation on private consumption and labour, internal habit formation on public expenditure, partial indexation of prices and wages on past inflation and decreasing returns to scale in the production technologies.In this chapter, for simplicity CES are transformed into log, productivity has constant return to scale, indexations are set to zero.

[2] A number of explanations on the model blocks are repeated here to allow for independent chapter reading.

and also serve as numéraires in our model. The resulting relationships between aggregated and retail prices and quantities read:

$$y^1(\varepsilon,t) = \left(\frac{P^1(\varepsilon,t)}{P_t^1}\right)^{-\theta_1} Y_t^1, \tag{3.5}$$

$$y^2(\varepsilon,t) = \left(\frac{P^2(\varepsilon,t)}{P_t^2}\right)^{-\theta_2} Y_t^2. \tag{3.6}$$

Aggregation of private consumption

In both countries, households have access to the aggregated goods produced by each country; domestic and foreign goods are partial substitutes. Private consumption of good i is denoted $C_{i,t}$. It represents the total consumption of good i in both countries and differs from private consumption in country i, denoted C_t^i. We have the following relationships:

$$C_{i,t} = C_{i,t}^1 + C_{i,t}^2, \tag{3.7}$$

$$C_t^i = C_{1,t}^i + C_{2,t}^i, \tag{3.8}$$

and

$$C_t^i = \frac{{C_{i,t}^i}^{1-\alpha_i} {C_{j,t}^i}^{\alpha_i}}{(1-\alpha_i)^{1-\alpha_i}\alpha_i^{\alpha_i}}, \tag{3.9}$$

where C_t^i is the private consumption of country i, and $C_{j,t}^i$ is the private consumption in country i of the aggregated goods produced in country j. α_i is the import share of country i. The corresponding consumption price index is given by

$$CPI_t^i = {P_t^i}^{1-\alpha_i} {P_t^j}^{\alpha_i}. \tag{3.10}$$

This aggregation yields the following relation between the demands for domestic and imported goods and their relative prices:

$$C^1_{2,t} = \alpha_1 \left(\frac{P^1_t}{P^2_t}\right)^{1-\alpha_1} C^1_t, \tag{3.11}$$

$$C^1_{1,t} = (1-\alpha_1) \left(\frac{P^2_t}{P^1_t}\right)^{\alpha_1} C^1_t, \tag{3.12}$$

$$C^2_{1,t} = \alpha_2 \left(\frac{P^2_t}{P^1_t}\right)^{1-\alpha_2} C^2_t, \tag{3.13}$$

$$C^2_{2,t} = (1-\alpha_2) \left(\frac{P^1_t}{P^2_t}\right)^{\alpha_2} C^2_t. \tag{3.14}$$

3.1.2 Households

In both countries, each agent (τ) maximises her intertemporal utility function subject to its budget constraint (determined by the recursive law of motion of private assets).

Consumption decision

Agents derive utility from consuming the bundle described above and disutility of labour. Each agent provides a differentiated labour supply that allows her to negotiate her wage.

Hence, this agent solves:

$$\max_{C^i(\tau,t),A^i(\tau,t)} E_0 \sum_0^\infty \beta^t \left(ln(C^i(\tau,t)) - \kappa L^i(\tau,t) \right), \tag{3.15}$$

$$\tag{3.16}$$

subject to

$$\begin{aligned} A^i(\tau,t) = &\left(1 + r_{t-1} - \psi\left(\frac{A^i_{t-1}}{P^i_{t-1}\bar{Y}^i}\right)\right) A^i(\tau,t-1) \\ &+ w^i(\tau,t)L^i(\tau,t) - CPI^i_t(1+\nu^{c,i}_t)C^i(\tau,t) + B^i_t. \end{aligned} \tag{3.17}$$

where, E_0, β are respectively the expectation at the initial time operator and the discount factor; $A^i(\tau,t)$ is the household's τ asset holdings at the end of period t; ψ is an interest premium on debt (whose function we detail in the paragraph on private asset dynamics); $L^i(\tau,t)$ is the labour supply of household τ and $w^i(\tau,t)$ its wage. $\nu^{c,i}_t$ is the tax rate on consumption or VAT through which government expenditure G^i_t is partially financed. σ^i_l

is the inverse of the Frisch elasticity. h_c^i, h_l^i are the external habit formation parameter on consumption and labour. B_t^i is the bonus or dividend paid by the firm to its employees or owner (if negative, it represents a recapitalisation of the firm). r_t is the interest rate set by the monetary authority in the union; CPI_t^i is the consumption price index in country i and κ is the weight assigned to labour in the utility function.

The Euler equation for this programme is identical across households:

$$E_t \left(\beta \frac{C_t^i}{C_{t+1}^i} \frac{1 + r_t - \psi \left(\frac{A_{t-1}^i}{P_{t-1}^i \bar{Y}^i} \right)}{\Pi_{t+1}^{c,i} \frac{1+\nu_{t+1}^{c,i}}{1+\nu_t^{c,i}}} \right) = 1, \tag{3.18}$$

where $\Pi^{c,i}$ is the inflation of the consumption price index in country i.

Private asset dynamics

The aggregate budget constraint reads:

$$A_t^i = \left(1 + r_{t-1} - \psi \left(\frac{A_{t-1}^i}{P_{t-1}^i \bar{Y}^i} \right) \right) A_{t-1}^i + w_t^i L_t^i - CPI_t^i (1 + \nu_t^{i,c}) C_t^i + B_t^i. \tag{3.19}$$

Labour supply decision

As we did for consumption goods, we model labour aggregation with a Dixit–Stiglitz function. Unlike consumption goods, labour is considered immobile and cannot be imported or exported. Relationships between labour and wages are therefore similar to those between consumption and prices. θ_w^i denotes the elasticity of substitution of labour. Households choose their labour supply (a labour aggregator or employment agency allocates workers to firms and sets a number of hours worked and an hourly wage as in Erceg, Henderson, and Levin (2000)). The relationship between total demand for labour and each household supply reads:

$$L^i(\tau, t) = \left(\frac{w^i(\tau, t)}{w_t^i} \right)^{-\theta_w^i} L_t^i. \tag{3.20}$$

We assume wage stickiness à la Calvo, with parameter ξ_w^i, the probability not to adjust wages at each period. Households negotiate the purchasing power of their net revenue, $PPNR_t^i = \frac{w_t^i}{CPI_t^i(1+\nu_t^{c,i})}$. Once linearised, this yields the following wage Phillips curve[3]:

$$\begin{aligned}
&\widehat{PPNR}_t^i - \widehat{PPNR}_{t-1}^i + \hat{\Pi}_t^{c,i} + \frac{\bar{\nu}^{c,i}}{1+\bar{\nu}^{c,i}}(\hat{\nu}_t^{c,i} - \hat{\nu}_{t-1}^{c,i}) = \\
&\beta\left(\widehat{PPNR}_{t+1} - \widehat{PPNR}_t + \frac{\bar{\nu}^{c,i}}{1+\bar{\nu}^{c,i}}\left(\hat{\nu}_{t+1}^{c,i} - \hat{\nu}_t^{c,i}\right) + \hat{\Pi}_{t+1}^{c,i}\right) \\
&+\frac{(1-\beta\xi_w^i)(1-\xi_w^i)}{\xi_w^i}\left(\hat{C}_t^i - \widehat{PPNR}_t\right),
\end{aligned} \tag{3.21}$$

3.1.3 Firms

We posit that firms hire a share of the aggregate domestic labour supply so that their labour cost is $w_t^i(1+\nu_t^{w,i})$ in country i at date t. $\nu_t^{w,i}$ is the payroll tax rate levied by the government on firms. In each country i, firm ε produces the differentiated good $y^1(\varepsilon,t)$ with the following technology:

$$y^i(\varepsilon,t) = \zeta_t^i\left(L_t^i(\varepsilon)\right)^\alpha, \tag{3.22}$$

$$\tag{3.23}$$

with production cost equal to:

$$w_t^i(1+\nu_t^{w,i})L_t^i(\varepsilon), \tag{3.24}$$

where ζ^i is the total factor productivity in country i modelled as exogenous and α is the production technology parameter.

Price setting

For price setting, we assume a Calvo process in each country. Firm ε, can reset its price with exogenous probability $1-\xi_i$. Producers know the relationship between their price and the demand for their product and choose their price to maximise their expected

[3]Note: $\hat{X}$ is variable X's log-deviation from its steady-state value $\bar{X}$

profit under that constraint. Firm ε chooses its price $\tilde{P}^i(\varepsilon,t)$ to maximise their expected profit until the next price setting:

$$\max_{\tilde{P}^i(\varepsilon,t)} E_t \sum_{T=t}^{\infty} (\beta\xi^i)^{T-t} \lambda_T^i \left(\tilde{P}^i(\varepsilon,t,T)\tilde{y}^i(\varepsilon,t,T) - w_T^i(1+\nu_T^{w,i})L^i(\varepsilon,t,T) \right), \tag{3.25}$$

subject to

$$\tilde{y}^i(\varepsilon,t,T) = \left(\frac{\tilde{P}^i(\varepsilon,t,T)}{P_T^i} \right)^{-\theta_i} Y_T^i \tag{3.26}$$

$$y^i(\varepsilon,t) = \zeta_t^i \left(L_t^i(\varepsilon) \right)^{\alpha}, \tag{3.27}$$

where $\lambda_T^i = \frac{1}{CPI_T^i C_T^i}$ is the marginal utility of consumption in country i in nominal terms. $\tilde{y}^i(\varepsilon,t,T)$ is the demand for goods produced by firm ε of country i at time T when its price was last reset at time t.

This leads to a standard linearised New-Keynesian Phillips curve:

$$\begin{aligned} \hat{\Pi}_t^i =& \beta\hat{\Pi}_t^i + \frac{(1-\beta\xi^i)(1-\xi^i)}{\xi^i} \\ & \left[\widehat{PPNR}_t^i + R\hat{P}C_t^i + \frac{\bar{\nu}^{w,i}}{1+\bar{\nu}^{w,i}}\hat{\nu}_t^{w,i} + \frac{\bar{\nu}^{c,i}}{1+\bar{\nu}^{c,i}}\hat{\nu}_t^{c,i} - \hat{\zeta}_t^i \right], \end{aligned} \tag{3.28}$$

where $RPC^i = CPI_t^i / P_t^i$ is the relative price of consumption with respect to the price of production in country i and

$$RPC_t^1 = \left(\frac{P_t^2}{P_t^1} \right)^{\alpha_1}, \tag{3.29}$$

$$RPC_t^2 = \left(\frac{P_t^1}{P_t^2} \right)^{\alpha_2}. \tag{3.30}$$

Dividends redistribution

Firms cannot save or invest, so they redistribute their profits to households. This distribution can be thought of as bonuses B_t^i to employees or dividends to firm owners, and when negative it is similar to a recapitalisation of the firm,

$$B_t^i = P_t^i Y_t^i - w_t^i(1+\nu_t^{w,i})L_t^i. \tag{3.31}$$

At the steady state, firms make zero profit and bonuses are equal to zero.

3.1.4 Market Clearing

Every period, markets clear in quantities in both countries:

$$Y_t^i = C_{i,t}^i + C_{i,t}^j + G_t^i. \tag{3.32}$$

This can also be written as follows:

$$P_t^i Y_t^i = CPI_t^i C_t^i + P_t^i G_t^i + P_t^i X_t^i - P_t^j M_t^i, \tag{3.33}$$

where X_t^i gives the exports sold to country j at the price of the domestic good. Likewise, the imports M_t^i are bought from country j at price P_t^j. Because demand for foreign goods is addressed by households only, we have $M_t^i = C_{j,t}^i = X_t^j$.

3.1.5 Monetary Authority

The central bank sets the nominal interest rate R_t common to both countries through a Taylor rule (Taylor, 1993) where it reacts to both the average inflation of the consumption price index[4] over the last year and to the average output gap.

$$R_t = R_{t-1}^{\rho} \left(R^* \prod_{i=t-3}^{t} \Pi_i^{\frac{r_\pi}{4}} Y_t^{r_y} \right)^{1-\rho} \tag{3.34}$$

where $\Pi_t = \frac{\bar{Y}_1}{\bar{Y}_1+\bar{Y}_2} \Pi_t^{c,1} \frac{1+\nu_t^{c,1}}{1+\nu_{t-1}^{c,1}} + \frac{\bar{Y}_2}{\bar{Y}_1+\bar{Y}_2} \Pi_t^{c,2} \frac{1+\nu_t^{c,2}}{1+\nu_{t-1}^{c,2}}$ is the average inflation of consumption in the monetary union, $Y_t = Y_t^1 + Y_t^2$ the total output of the monetary union, R^* is the interest-rate target of the central bank. r_π and r_y are the Taylor rule weights assigned to inflation and the output gap, ρ is the interest-smoothing parameter.

3.1.6 Fiscal Authorities

As detailed in the previous chapter, governments can take three possible discretionary fiscal measures: change the level of public spending or the VAT rate, or the payroll tax. Otherwise, governments maximise their objective function the utility function with respect to public expenditure subject to the public budget constraint.

[4] Reacting to the (VAT-included) CPI inflation makes the central bank also react to changes in the VAT level set by the government. Indeed VAT increases have inflationary effects.

Objective function of the government

The objective of the government is to stimulate domestic production and labour, to provide collective good and services, as well as individual consumption, all these dimensions of public intervention are embedded into the variable G as explained earlier. Moreover, the overall level of government spending is assumed to be persistent, as welfare state systems cannot be dramatically reshaped overnight, hence we model the objective function of the government as a CES function of public spending with internal habit formation, in the simplified version of the model exposed here, this objective is the logarithm of government spending. Governments maximise their objective function with respect to public spending G, subject to the public budget constraint:

$$\max_{G_t^i} E_0 \sum_{t=0}^{\infty} \beta^t ln(G_t^i), \tag{3.35}$$

$$\text{subject to } PA_t^i = (1 + r_{t-1} - \psi^g(\frac{PA_{t-1}^i}{P_{t-1}^i \bar{Y}^i}))PA_{t-1}^i + \nu_t^{w,i} w_t^i L_t^i + \nu_t^{c,i} CPI_t^i C_t^i - P_t^i G_t^i, \tag{3.36}$$

where PA_t^i denotes the nominal public assets of country i at the end of period t (negative if the government is a borrower). Note that the atomicity assumption made for households does not hold for governments, the latter are subjected to the public debt premium ψ^g and accordingly habit formation on government consumption is internal. This yields the following Euler equation for government consumption (or discretionary expenditure),

$$E_t \beta \frac{G_t^i}{G_{t+1}^i} \frac{1 + r_t - \psi^g(\frac{PA_t^i}{P_t^i \bar{Y}^i}) - \frac{PA_t^i}{P_t^i \bar{Y}^i} \psi^{g\prime}(\frac{PA_t^i}{P_t^i \bar{Y}^i})}{\Pi_{t+1}^i} = 1, \tag{3.37}$$

$$\tag{3.38}$$

and law of motion for public asset holdings,

$$PA_t^i = \left(1 + r_{t-1} - \psi^g \left(\frac{PA_{t-1}^i}{P_{t-1}^i \bar{Y}^i}\right)\right) PA_{t-1}^i + \nu_t^{w,i} w_t^i L_t^i + \nu_t^{c,i} CPI_t^i C_t^i - P_t^i G_t^i. \tag{3.39}$$

Debt control in the government budget constraint

For governments, ψ^g captures the marginal cost of debt. This premium paid by governments on their debt (or assets) ensures that the governments' assets will not permanently depart from their steady state. In other words, the spread paid on sovereign bonds sets

an implicit limit on public debt by making credit more expensive as indebtedness level rises. This cost is internalised by the government: it keeps the debt level under check through changes in public expenditure levels. In the context of the eurozone sovereign-debt crisis, this premium may be interpreted as the spread on sovereign yields compared to Germany. The implicit deficit limit on debt enforces indirectly a deficit limit so the model tallies with the Maastrict criteria capping deficit and debt in the countries of the monetary union (at 3% and 60% of GDP respectively).

3.1.7 Financial Intermediation

As explained by Schmitt-Grohe and Uribe (2003), the stationarity of an open economy model is not straightforward. It can be ensured by some modelling elements, which are usually not microfounded (and akin to habit parameters that ensure the hump-shaped response of consumption to shocks). In order to substantiate the introduction of spreads at the micro level, we detail the following financial market mechanisms.

We assume that there exists an international financial market for assets (private or public). On the financial market, intermediaries can borrow money from the central bank to finance public or private credit, and conversely borrow money from agents to deposit it at the central bank. Through financial intermediaries, agents can purchase other agents' and governments' assets. The interest rate for the exchange between the central bank and the financial intermediary is the interest rate set by the central bank. The aggregate *cash needs* financial intermediaries borrow from the central bank are:

$$CN_t = -(A_t^1 + A_t^2 + PA_t^1 + PA_t^2). \tag{3.40}$$

The *turnover, costs and profit* of financial intermediaries are

$$\text{Turnover} = -\sum_{i=1,2}\left(r_t - \psi\left(\frac{A_t^i}{P_t^i \bar{Y}^i}\right)\right) A_t^i - \sum_{i=1,2}\left(r_t - \psi^g\left(\frac{PA_t^i}{P_t^i \bar{Y}^i}\right)\right) PA_t^i; \tag{3.41}$$

$$\text{Costs} = r_t CN_t + \Xi(A_t^1,\ A_t^2,\ PA_t^1,\ PA_t^2); \tag{3.42}$$

$$\text{Profit} = \sum_{i=1,2}\psi\left(\frac{A_t^i}{P_t^i \bar{Y}^i}\right) A_t^i + \sum_{i=1,2}\psi^g\left(\frac{PA_t^1}{P_t^i \bar{Y}^i}\right) PA_t^i - \Xi(A_t^1,\ A_t^2,\ PA_t^1,\ PA_t^2); \tag{3.43}$$

where $r_t CN_t$ is the financial cost of this activity and $\Xi(A_t^1,\ A_t^2,\ PA_t^1,\ PA_t^2)$ gives the intermediation and management costs. We assume that financial intermediaries evolve

on a perfect competition market with quadratic intermediation and management costs[5] such that profits are equal to zero. Financial intermediaries do not re-inject the cashed-in fees back into the union economy. Therefore developments on the financial market do not affect the rest of the system. As a consequence, the optimisation programme of financial intermediaries is not needed to close our model. One could for instance assume that financial activities are based strictly out of the monetary union, for instance in England or in Switzerland. Moreover, we suppose that, at each period, the financial intermediaries clear their position towards the central bank so that:

$$CN_t = -(A_t^1 + A_t^2 + PA_t^1 + PA_t^2) = 0. \tag{3.44}$$

This last condition imposes that at each period, private and public debts or assets held in the monetary union cancel each other out. This condition may be found restrictive it is nevertheless comparable to the interbank overnight markets, where banks clear their daily position towards the central bank by lending or borrowing according to the refinancing rate set by the central bank. This ensures that the debt market is Walrassian, i.e. that the laws of motions for three out of four of the assets (public and private in both countries) implies the law of motion for the fourth one.

3.2 Fiscal Stimuli in a Monetary Union after a Crisis

3.2.1 Simulation Strategy

In this section, our goal is to simulate the recovery from a global recession in a monetary union and to determine the type of fiscal measure that best counteracts the depressive effects of a crisis. In an attempt to replicate the extraordinary conditions of European countries hit by the 2008-9 subprime crisis, we compute deterministic simulations of the model and calibration detailed in the previous chapter with two symmetric countries starting off the-steady-state. Fiscal expansions are usually a response to negative exogenous shocks. These particular circumstances induce a "simultaneity downward bias" in the assessment of fiscal multipliers because fiscal expansions are usually implemented when the economy is depressed. The scope of the variables' reactions is therefore bound to be lower than in the previous chapter where simulations started from the steady-state. We take the following assumptions for the starting point:

[5] Contracts between the financial intermediaries and households or government are embedded in the function ψ and ψ^g. There is no moral hazard, default or collateralisation in our model.

- GDP in both countries is 5% below its steady state for the second quarter at the beginning of the simulation;
- government expenditures are still at their steady state at the beginning of the simulation;
- prices have not responded to the crisis at the starting point; hence, inflation, relative prices and terms of trade are at their steady state;
- governments and households have not adjusted their savings behaviour at the starting point, so asset holdings are at their steady state;
- other real quantities at the beginning of the simulation are deduced from the model's equations.

As discussed by Mountford and Uhlig (2009), fiscal shocks encompass a wide array of measures (from discretionary spending to tax cuts) and effects (revenue versus spending shocks, for instance). We select the following shocks as policy responses implemented in the wake of the crisis:

(i) a positive discretionary expenditure shock in the home country;

(ii) a cut in the VAT in the home country;and

(iii) a drop in the labour tax levied on domestic firms.

We compare the recovery of both countries from this crisis with respect to the different measures undertaken by the government. We also compute simulations for the case where the government takes no measure as controls. For the purpose of comparability, we specify that the cost of any of these measures must equal 3% of the country's GDP. This figure is roughly in line with European Commission estimates of fiscal packages implemented by national governments in the eurozone (which amounted to 1.5% of GDP in 2009). More precisely, this amounts to a 10% increase in public spending, or a 2.8% VAT cut or a 2.4% payroll tax cut for a period of four quarters.[6]

In this chapter, we focus on the cross-country externalities fiscal policy shocks generate. We first rely on a perfectly symmetric framework – i.e., both countries making up the union are identical in all aspects and will introduce asymmetries in a subsequent section.

[6]These amounts are computed as follow: respectively $\Delta G^i = \frac{3\%}{\frac{\bar{G}^i}{\bar{Y}^i}}$, $\Delta \nu^{c,i} = \frac{3\%}{\frac{\bar{C}^i}{\bar{Y}^i}}$ and $\Delta \nu^{w,i} = \frac{3\%}{(1+\nu^{c,i})\frac{\bar{C}^i}{\bar{Y}^i}}$, because at the steady-state we have the following equality between the wage and consumption: $\bar{w}^i = (1+\nu^{c,i})\bar{C}^i$.

3.2.2 Differentiated Effects of Fiscal Policy Shocks

Figures 3.1 to 3.3 display the simulations of our model's recovery from a crisis with the baseline calibration. We compare the effects of our three alternative fiscal policies. The reactions are measured in percentage-point deviations from the steady state. We rely on the simulations when no fiscal measure is undertaken to comparatively assess policy effects.

The crisis unfolding with passive fiscal authorities

When there is no fiscal shock following the recession, the central bank lowers the interest rate by 50 basis points to stimulate economic activity. As demand is low, households have little bargaining power, and the hourly wage falls below its steady-state level by more than 3%. By rapidly increasing their labour supply,[7] households manage to cushion the drop in their consumption and increase their savings. The governments, facing a drop in tax intake, so that they cut expenditures by more than 1% lest the public debt soar. However, both governments partially resort to debt – a 2.5% increase – in order to smooth out their consumption.

For domestic activity, the best policy is to increase government consumption

From the viewpoint of country 1, which initiates a fiscal stimulus, resorting to government spending yields the largest positive effect on domestic activity. Indeed, by increasing its demand for domestic goods, the government's purchase of domestic production has a direct effect on output, buoying it to roughly 2% over that of the recovery without fiscal measures. As the stimulus is worth 3% of the GDP, our fiscal multiplier is about 0.66, which is in line with the figure reported by Monacelli, Perotti, and Trigari (2010). This increase in public demand pushes wages up, which in turn spurs private savings as well as home and imported consumption. Indeed, as the labour supply goes up with the shock, so does household income. The government, by adjusting its spending, will in the long run satisfy the no-Ponzi-scheme condition.

[7] If the inverse intertemporal elasticity of substitution of private consumption, $\sigma_c < 1$, this increase in hours worked will be even more abrupt as the substitution effect prevails over the income effect.

Tax cuts have less expansionary effects on output

Comparatively, tax cuts have a mediated impact on production through prices – directly on domestic and imported goods for the VAT cut and indirectly, through a cross-border deflationary pressure for the payroll tax – , explaining their more muted effect on output.

This hierarchy of fiscal measures according to their effect on output differs from that of Faia, Lechthaler, and Merkl (2010). Notwithstanding differences in the modelling of the labour block, they find that the effects of increasing public spending or tax cuts – in an open economy calibrated to the EMU – are nearly zero, while that of hiring subsidies (comparable to a cut in the payroll tax in our setting) helps the economy recover substantially.

However, as mentioned in the previous chapter, the effects of tax cuts depend on the value of the intertemporal elasticity of substitution of consumption. In the Appendix (see Figures A-1 to A-2), we show the same policy simulations with different values for this parameter. If the value for the elasticity of substitution is high (i.e. $\sigma_c < 1$), the substitution prevails. This spurs the labour supply of households at the expense of consumption smoothing as households work more to earn more (as leisure has become relatively more expensive) and drives the recovery. Conversely, if it is low (i.e. $\sigma_c > 1$), with $\sigma_c = 2$ for instance, the income effect dominates. The drop in prices and wages drives the labour supply down so that tax cuts depress output and consumption more than fiscal inactivity would. However, only with a very high elasticity of substitution ($\sigma_c = 0.2$), would VAT cuts and public spending-based expansions have comparable effects on domestic GDP.

All fiscal stimuli produce positive externalities for the other country

In our model, increasing public spending in country 1 crowds out the domestic market and thus boosts imports from country 2. This is in line with the empirical results of Beetsma, Giuliodori, and Klaassen (2005): they show that in the EMU, an increase in government in one country spending translates into more foreign exports ($+2\%$) from its EMU neighbours.

Tax cuts in country 1 force country 2 to be more price-competitive. The mechanisms at play are the following: a cut in the VAT also impacts on imports ($+3\%$) and so on prices (-0.45%) and quantities in country 2. There, labour and the real wage are pushed up, as is country's 2 output. The transmission channel for the spillover effect is the interest rate, hence the strong positive effect on domestic consumption with an increase of 2% more

than in a passive government scenario. Indeed the central bank reacts to VAT-included consumption prices and cuts the interest rate by 80bp.

By decreasing the payroll tax, country 1 generates disinflation of domestic production that spreads to country 2 through the Phillips curve and stimulates its production. Reactions of economic variables to the payroll tax cut are generally more muted because there is no direct reaction of the central bank to this measure, indeed the interest rate curve almost superposes with that in the case of a government spending.

Thus, for all policy measures taken in country 1, there are positive spillover effects for country 2. So for country 2, it is always better to have its neighbour undertake any fiscal expansion measure than none.The positive deviation of foreign output ranges between $+1\%$ for a spending-based expansion and $+1.4\%$ for a VAT cut. This partially debunks the tenet of the Stability and Growth Pact by which fiscal expansion is held to be detrimental to other eurozone members: such an effect is not obvious in the short term.

Parameters calibration and the size of spillovers

The size of the spillovers depend on the reactivity of country 2 and its capacity to compete on prices. In a symmetric union, the positive effect on GDP equals ranges in $[+0.2\%, +0.6\%]$ deviation from its steady-state value according to the policy measure. For country 2 to free ride propitiously on the expansion of country 1, the nominal adjustments induced by the Phillips curves must not translate into large adjustments in quantities of goods and labour. This ability hinges on price flexibility captured by the Calvo parameter ξ_i but also on two other parameters – σ_c the inverse intertemporal elasticity of substitution and to a lesser extent σ_l the inverse of the Frisch elasticity – present in the wages and prices Phillips curves. The smaller these two parameters are, the less agents will adjust to changes on prices and wages through quantities and the larger the fiscal spillovers will be in terms of output.

More precisely, for higher values of σ_l, the labour supply sensitivity (or convexity of the disutility of labour) is stronger, and asymmetries in the monetary union are less reflected in the size of fiscal spillovers. Indeed, agents adjust more swiftly to policy shocks, and this downplays the effects of the other differentiated fiscal policy channels.

Figures A-1 to A-2 in the Appendix compare policy simulations with different values for σ_c. The ordering of policies in terms of positive spillovers varies. In our baseline calibration, the inverse intertemporal elasticity of substitution in the CES utility function, $\sigma_c = 1$. In this case, the VAT cut provides about $+0.5\%$ on home output and about $+0.8\%$ on foreign output compared with a passive government. The spillover effects of

a spending-based expansion and a VAT cut are comparable. However, with $\sigma_c = 0.5$ for instance, country 2 will benefit more from a VAT-cut than from a spending-based expansion in country 1, with a deviation of GDP worth $+3\%$.

Fiscal policy as an unconventional tool for monetary policy

By increasing demand, the government prevents the central banker from having to lower the interest rate too much in the wake of the crisis (offering a 10 to 20 basis point ease on the central banker). On the contrary, by decreasing tax levels the government – while stimulating activity – also generates disinflation, which forces the central banker to decrease nominal interest rates even more. This may prove a perilous exercise when interest rates are already close to their zero lower bound. The interest cut is the largest (-80bp) after a VAT cut and reaches its maximum four quarters after the tax cut as the central bank reacts to year-average CPI inflation (tax included).

For the central banker, buying public assets when the national governments increase their spending yields a larger boost to the economy with a smaller nominal cut in the interest rate. Such an efficient non-conventional use of monetary policy could result from cooperation between monetary and fiscal authorities but is not foreseen in the settings of the currency area.

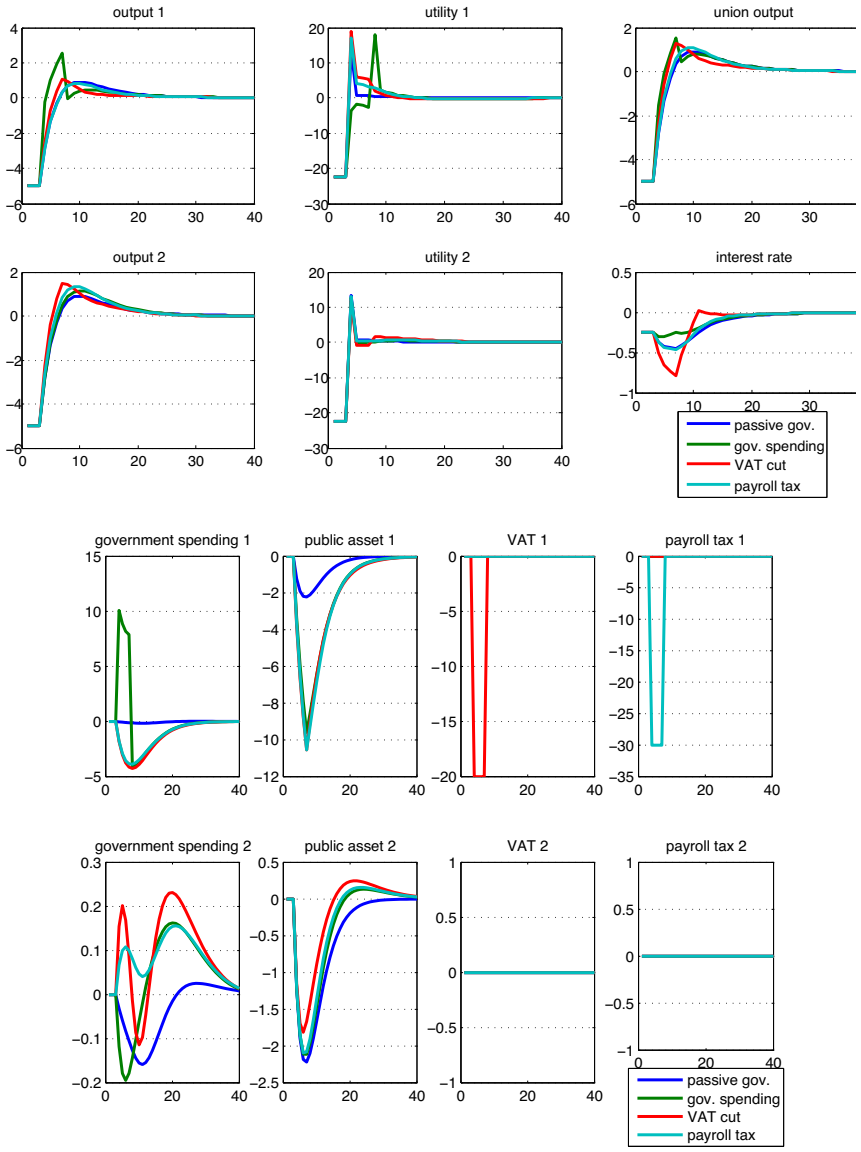


Figure 3.1: Output variables following fiscal stimuli in country 1

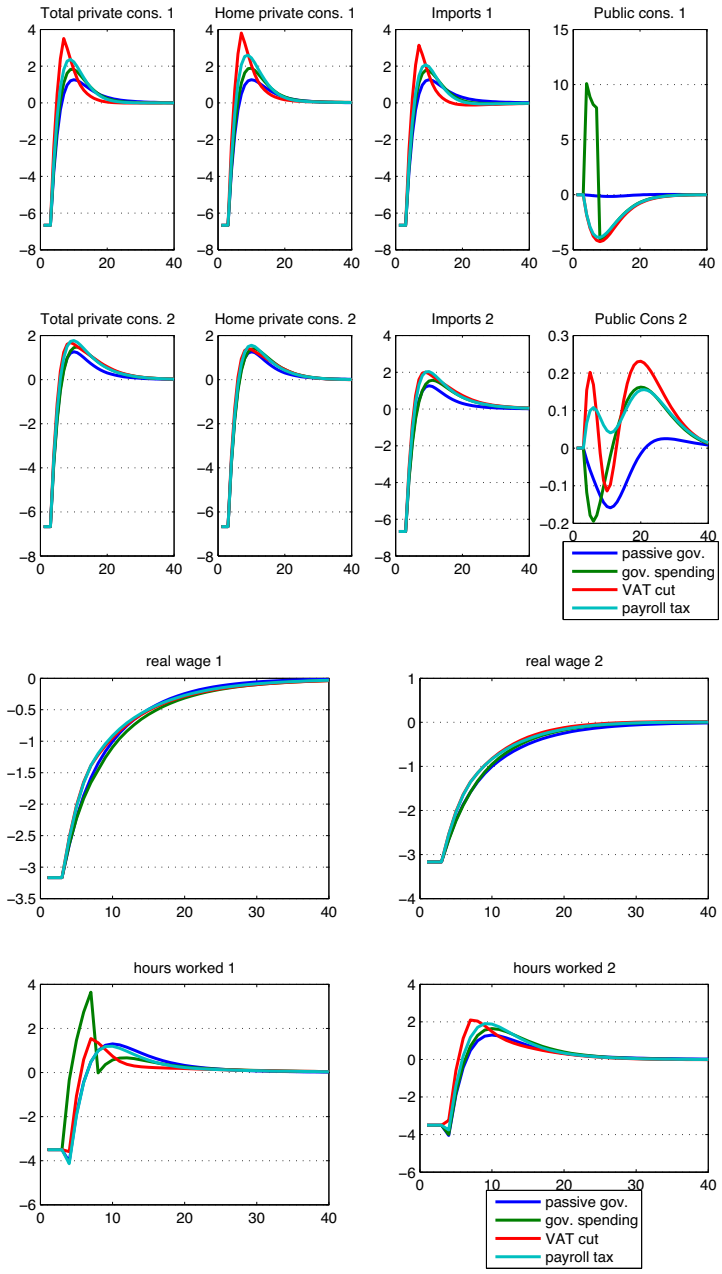


Figure 3.2: Consumption variables following fiscal stimuli in country 1

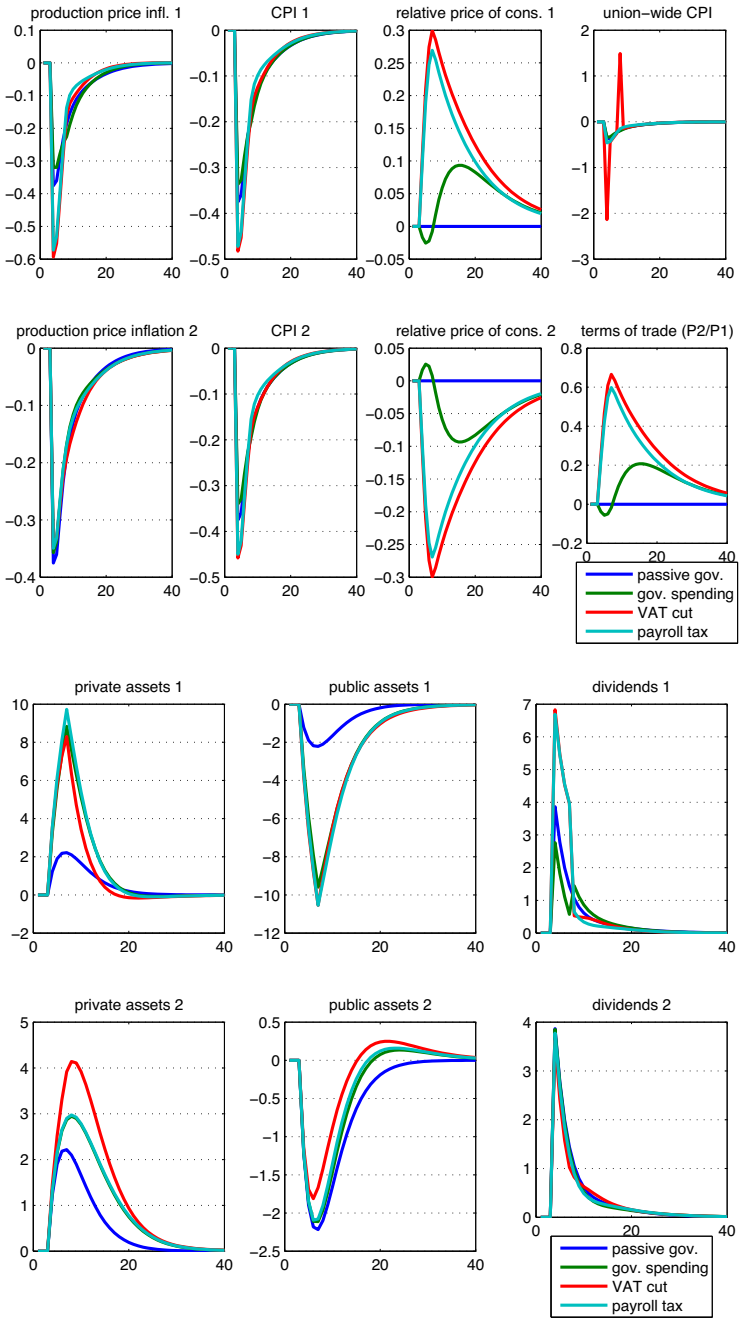


Figure 3.3: Nominal variables following fiscal stimuli in country 1

3.2.3 Robustness of the Simulations

We now check that these results do not crucially hinge on the off-the-steady-state starting point of the simulations and how we specified it. We thus compare the previous simulations (Figures 3.4 to 3.6) first with simulations of fiscal shocks starting from the steady-state and second with a crisis induced by shocks on productivity and preferences. In this case, we generate a supply shock of -5% on productivity and a confidence shock of -5% on β, the discount factor affecting the households' Euler equations, shocks have an auto-correlation factor $\phi = 0.75$. As a consequence of these shocks, households become more risk-averse and postpone their consumption, which lowers demand immediately. Overall, fiscal shocks affect economic variables in the same direction and with the same comparative magnitude regardless of the starting point of our simulations. More precisely, our simulation choice is always in line with at least one of the alternative simulation (from the steady-state or after a productivity shock) and never displays an amplitude of reaction that is significantly greater than the other two options. In particular, reactions of foreign variables are greater following crises simulated with shocks showing that the magnitude of our spillover effect is not overestimated.

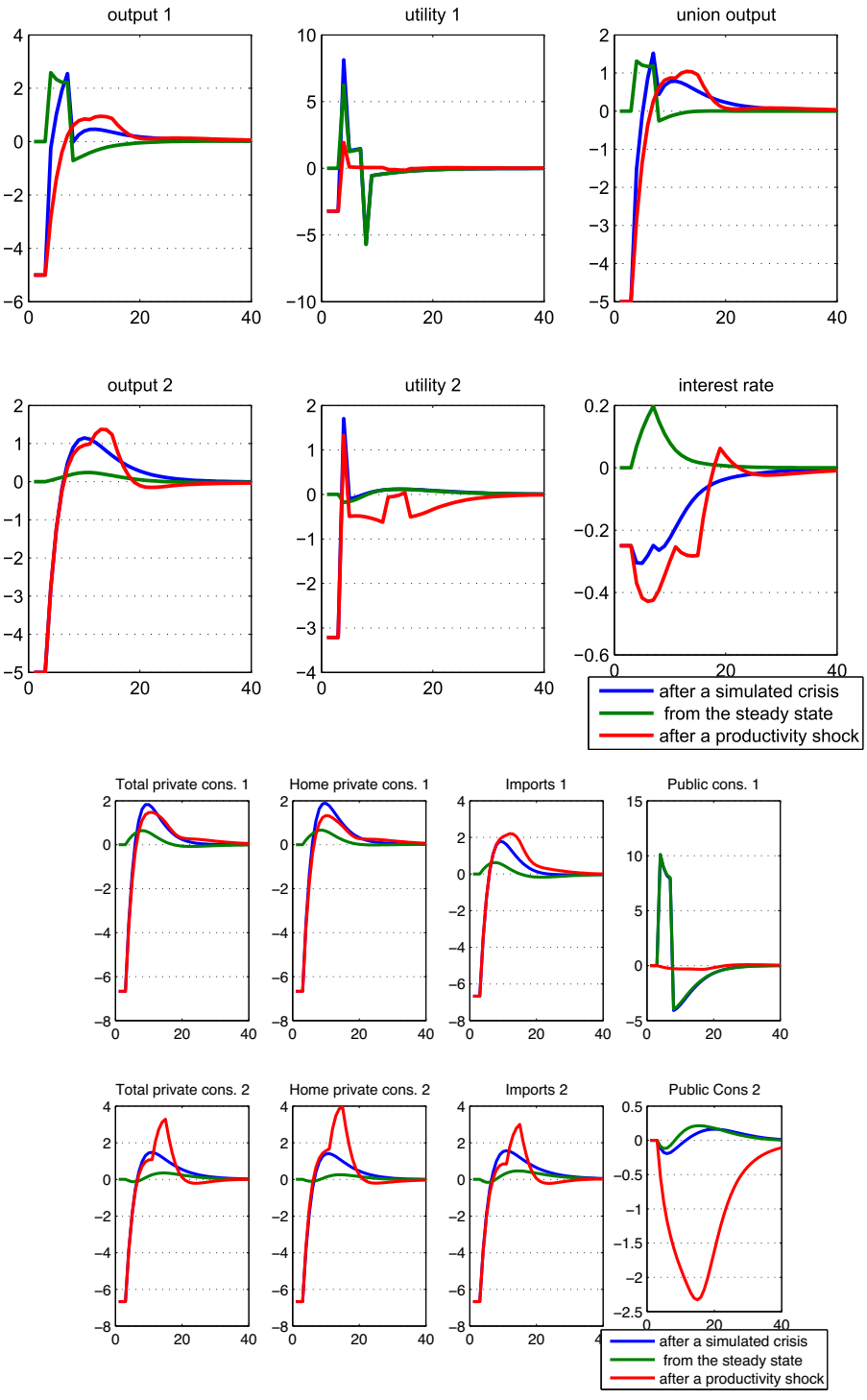


Figure 3.4: An increase in public spending in country 1

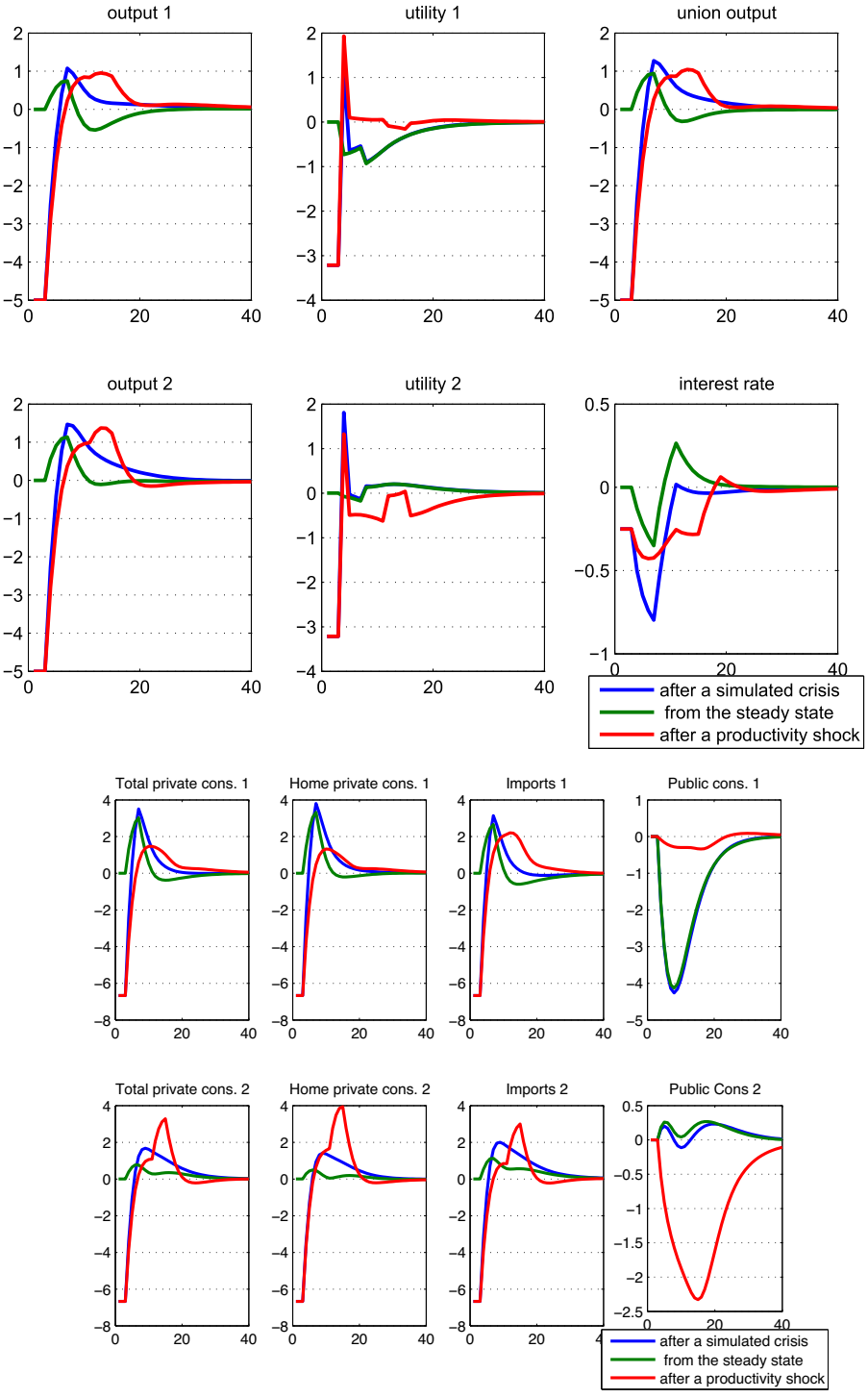


Figure 3.5: A VAT cut in country 1

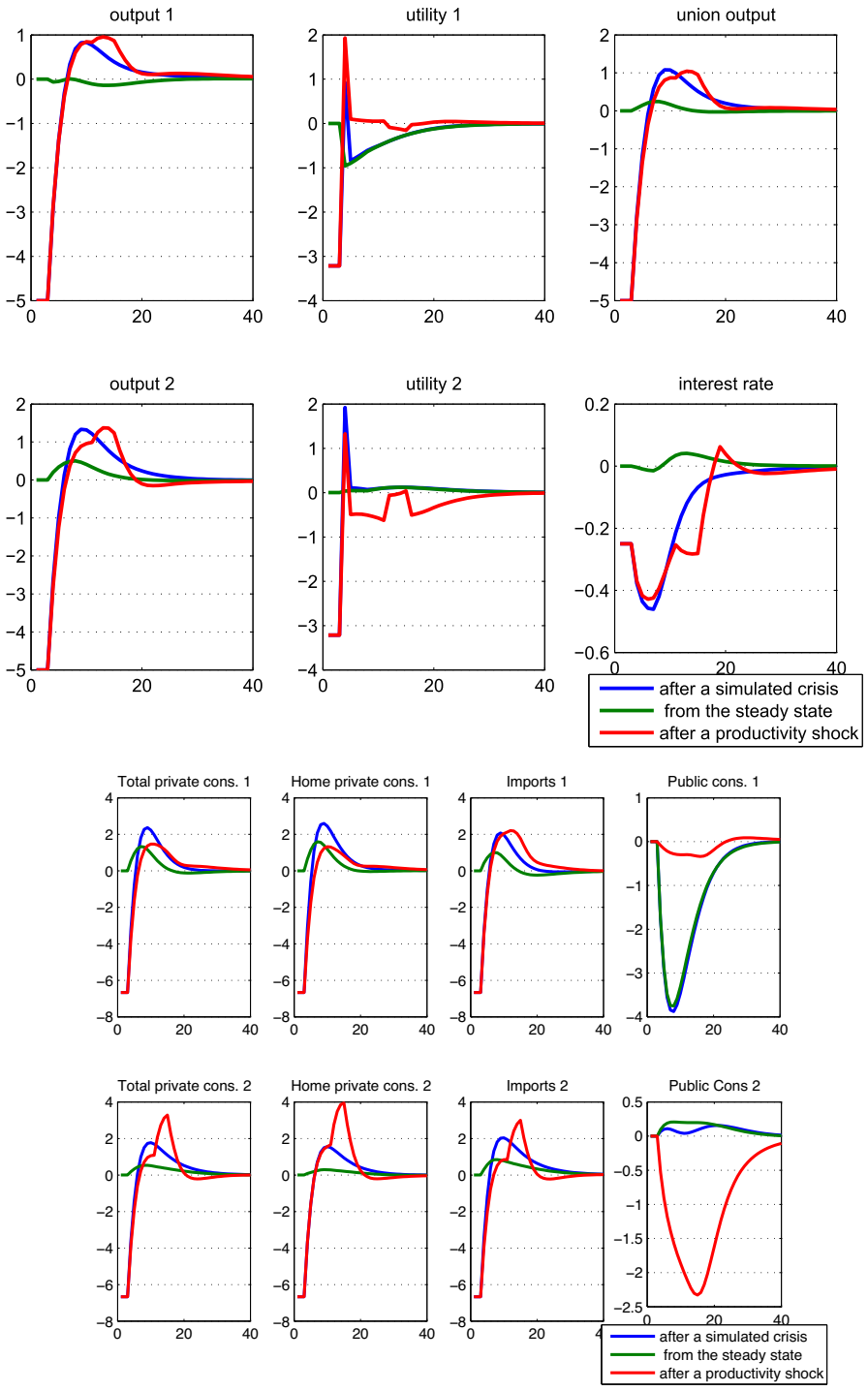


Figure 3.6: A payroll tax cut in country 1

3.3 Fiscal Spillovers in a Monetary Union

3.3.1 Country Size and Asymmetries in the EMU

In a symmetric monetary union, a country always benefits from its partner's fiscal stimuli. These benefits depend on the structural parameters of the utility function of households. In the euro area, countries differ not only in their price rigidities but also, more importantly, in their size and their degree of trade openness. In this section, we assess the effects of country size on fiscal shocks, cross-country spillovers and subsequent adjustments.

Country size matters in the monetary union because the effects of monetary and fiscal policies are different between small and large countries. On the monetary side, Romer (1993) and Sanchez (2006) show that because of their higher openness and consequently higher exchange-rate pass-through, small countries tend to have steeper Phillips curves so that the inflationary effects of real depreciations are usually larger in small, open economies. The conservative stance of the ECB regarding price stability increases incentives to carry out an active demand-side fiscal policy, and all the more so among countries that are large and thus have domestically driven economies. On the fiscal side, for instance, non-Keynesian effects tend to be observed in smaller economies because they do not rely as much on internal demand. Consequently, it may be easier for them to abide by the 3 % deficit limit of the Stability and Growth Pact. In other words, growth strategies of small countries (or economic policies emphasising external competitiveness) are accommodated by the general features of the EMU. In a recent review on the topic, Afonso and Sousa (2009) find that country size is negatively correlated with discretion (i.e., the unsystematic response of fiscal policy to output developments) and positively with persistence (i.e., the degree of dependence of present fiscal policy on its past values). Beetsma, Giuliodori, and Klaassen (2005) find that fiscal expansions abroad are propitious to small economies of the monetary union: according to their calculations, a 1% increase in Germany's government expenditures resulted in a 2.3% increase in European partners' exports to the country over a period of two years.

However, let us from the onset add nuance to our picture: the inverse relationship between country size and openness that is the underlying tenet of our theoretical model and economic reasoning by no means holds perfectly. For starters, on a world scale, the three "large" members of the EMU, Germany, France and Italy, are middle-sized economies driven both by internal demand and external competitiveness. Germany, the largest country by – with roughly 40% of the eurozone's GDP and 30% of its population

– is an export champion (8.2% of world merchandise trade in 2008, according to the WTO) and thus displays a very high openness rate (the sum of imports and exports represented 89% of GDP in 2008, according to Eurostat). Conversely, Greece, for instance, is a peculiarly closed economy for its size, with a 60% openness ratio. With these nuances in mind, we select *benchmark countries*, namely France and the Netherlands, as they match the average figures of large and small countries, respectively, of the EMU lumped together and allow us to reproduce the best actual data[8] while fulfilling our steady-state restrictions[9]. Thus, France and the Netherlands provide a good fit calibration-wise.

To evaluate how asymmetries influence spillovers, we consider the following alternative settings for the two-country monetary union:

- symmetric countries as our benchmark configuration;
- a "France-versus-Netherlands" configuration with the fiscal shock occurring in France (openness degrees $\alpha_1 = 0.2$, $\alpha_2 = 0.7$, $\theta = \frac{\bar{Y}^1}{\bar{Y}^2} = 3.5$);
- the same configuration with the shock occurring in the Netherlands, (in this case the Netherlands is country 1);
- the same asymmetric setting, to which we add nominal rigidities, assuming that France is more rigid, with $\xi_1 = 0.83$, and the Netherlands flexible, with $\xi_2 = 0.66$.

We thus rely on the following alternative calibration:

We introduce allow for national differences in the values of parameters α_i, θ and ξ_i.

Parameter α_i denotes the import share of private consumption (and, indirectly, the degree of openness of both economies) and is calibrated on averages of openness ratios (exports and imports as a share of GDP) over the last decade in Germany and France (for large countries) and Belgium, Ireland and the Netherlands (for the small countries). We thus adopt an average value of 0.45 for α_i in the baseline scenario, using 0.2 for the large country and 0.7 for the small country in the asymmetric case.

[8] The Netherlands displays an import share of 68% of GDP and a government consumption share of 25% of GDP; these figures are 28% and 23%, respectively, for France. The French GDP of 2 trillion euros represents roughly 3.5 times the Dutch GDP of 600 billion euros (Source: Eurostat, 2008). If both countries display similar levels of government consumption, their private consumption levels differ significantly, constituting 45% of GDP in the Netherlands and 57% in France. As we do not include investment in this model, we cannot account for these differences.

[9] Indeed, as explained in the section on calibration, we have to respect the feasibility relationship between the relative sizes of countries, their relative import shares (or openness) and government/private consumption shares. Bearing this in mind, we cannot plug in data for any pair of countries, as larger countries in terms of GDP, for instance, would have to be more closed than smaller ones by a factor roughly equal to their relative size.

Parameter	Description	Value	Alternative value
α	Production technology parameter	0.7	-
β	Discount factor	0.99	-
h_c^1, h_c^1	Habit formation on consumption	0.7	-
h_g^1, h_g^2	Habit formation on public expenditure	0.7	-
h_l^1, h_l^2	Habit formation on labour	0.7	-
σ_c^1, σ_c^2	Inverse of intertemporal elasticity of substitution of private consumption	1	2, 0.5
σ_l^1, σ_l^2	Inverse of the Frisch elasticity	2	-
σ_g^1, σ_g^2	Inverse of intertemporal elasticity of substitution of public expenditure	1	-
κ	Weight of labour in utility	see Model	-
α_1, α_2	Import share	0.45	0.2, 0.7
ξ_1, ξ_2	Calvo parameter on prices and wages adjustment	0.75	0.83/0.66
γ_1, γ_2	Price and wage indexation on past inflation	0.2	
θ_1, θ_2	Elast. of sub. of domestic products and labour yielding a markup of 20% on prices and wages	6	-
ψ_1, ψ_2	Financial premium on household debt	0.05	-
ψ_1^g, ψ_2^g	Financial premium on government debt	0.05	-
$\bar{v}^{c,1}, \bar{v}^{c,2}$	Tax level on consumption	20%	-
$\bar{v}^{w,1}, \bar{v}^{w,2}$	Tax level on wages	19%	-
r_π	Central Bank reaction to inflation	1.7	-
ρ	Taylor rule smoothing parameter	0.8	-
r_y	Central Bank reaction to output gap	0.25	-
θ	Economic size ratio $\bar{Y}^1/\bar{Y}^2$	1	3.5
$\bar{C}^1/\bar{Y}^1 = cy_1,$	Relative shares of private consumption in GDP	0.7	-
$\bar{C}^2/\bar{Y}^2 = cy_2$		0.7	-
$\bar{G}^1/\bar{Y}^1 = gy_1,$	Relative shares of government spending in GDP	$1 - cy1$	-
$\bar{G}^2/\bar{Y}^2 = gy_2$		$1 - cy2$	-

Table 3.1: Parameters calibration with alternative values

The economic size ratio is captured by θ. In the baseline scenario, countries are supposedly symmetric, so $\theta = 1$. In the asymmetric case, $\theta = 3.5$, so the large country (country 1) is 3.5 times bigger than the small one (country 2), which roughly reflects the size ratio in terms of GDP between France and the Netherlands.

Price rigidities are captured by ξ_i, the Calvo parameter. This is linked to the average duration of contracts through $E(duration) = 1/(1 - \xi_i)$. In line with the values commonly found in the literature (which assign contract durations from nine months to a year and a half), we choose $\xi_i = 0.75$. This value yields a price contract duration of one year. We allow for heterogeneity across price rigidities and use an alternative duration of 1.5 years for a more rigid country and nine months (ξ_1=0.83) for a more flexible country (ξ_2=0.66) as suggested by Benigno (2001).

3.3.2 Passive Government and Spillovers

When the government abstains from fiscal actions in the wake of the crisis (see passive government curve in Figures 3.7 to 3.9), the recovery path of each country's output will not depend on the relative sizes of the countries but on their prices and wage rigidity. Logically, the less flexible the country is, the longer it will take to recover from the crisis. There is obviously no policy-induced cross-border spillover.

3.3.3 Spillovers from an Increase in Government Spending

In the case of a fiscal expansion (Figures 3.7 to 3.9), policy effects are real as public consumption affect quantities. Fiscal spillovers in terms of output are larger when countries differ in terms of size and openness degree. As expected, adding a size bias increases the fiscal externalities exerted by the large country on the smaller one's output and has a much larger effect on spillovers than differences in price rigidities do. Indeed, the more open the small country is, the more its exports are impacted by the crowding-out effect of country 1's fiscal expansion.

As for price and wage flexibility, the more flexible country may in principle have an advantage over the rigid one, yet wages are also flexible upwards, hindering firms from competing in prices because wages increase more rapidly in country 2. Therefore, the level of nominal rigidities does not change the magnitude of the spillovers.

The central bank lowers the interest rate less sharply when fiscal expansion takes place in the large and rigid country because it is assigned more weight in its reaction function.

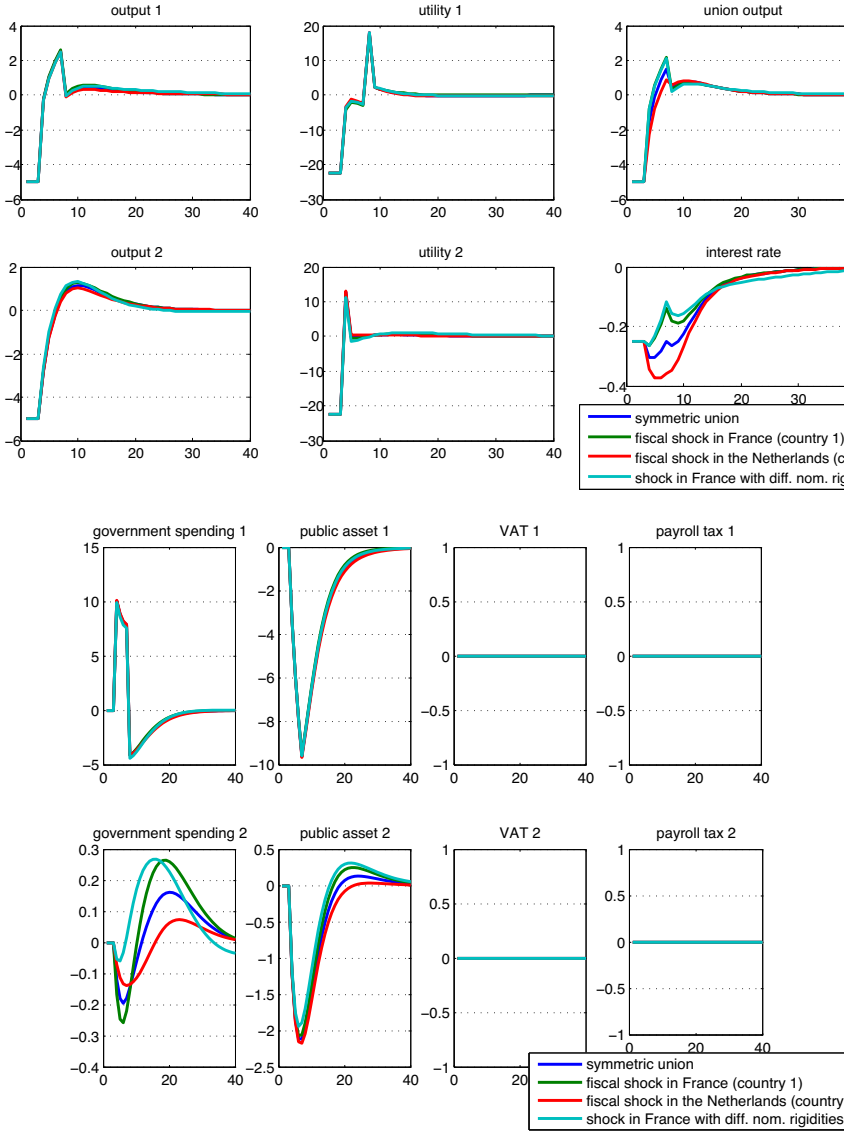


Figure 3.7: Effects and spillovers of an increase in public spending – 1 of 3

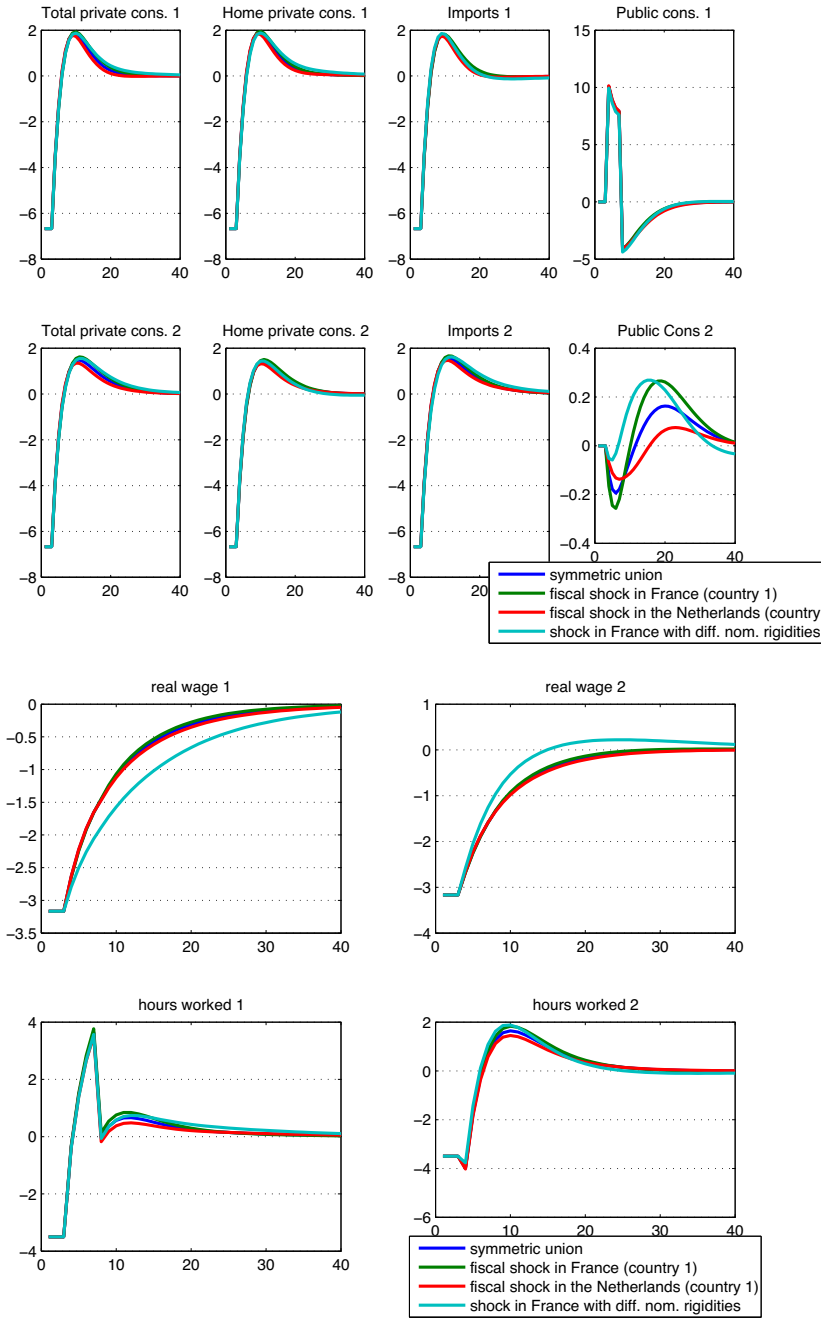


Figure 3.8: Effects and spillovers of an increase in public spending – 2 of 3

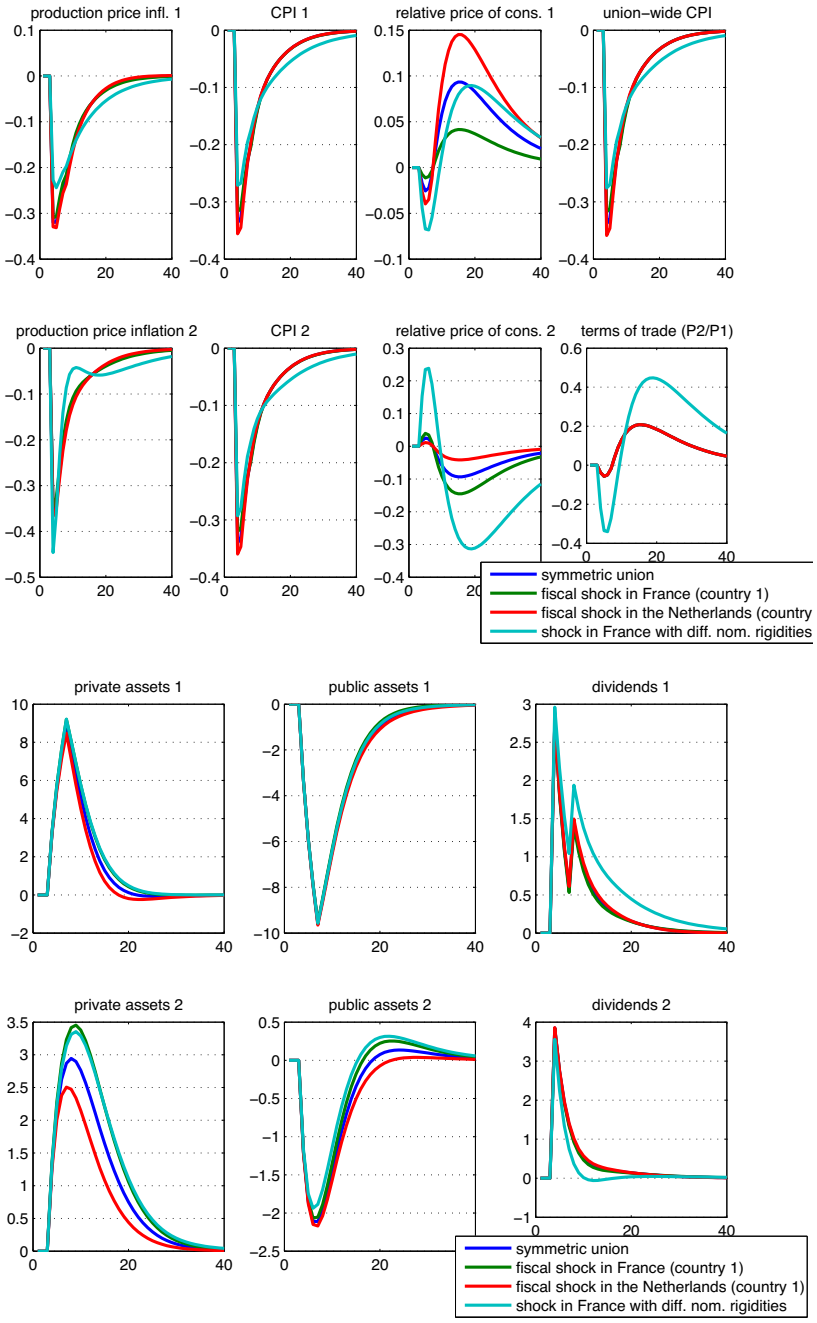


Figure 3.9: Effects and spillovers of an increase in public spending – 3 of 3

3.3.4 Tax-Cut Induced Spillovers

Tax cuts are passed on to the economic variables of our model through nominal channels. The VAT cut has a direct deflationary effect, prompting an accommodating reaction of the central bank (decrease in the interest rate), which translates into a lower real interest rate in country 2, where this spurs economic activity (labour, output). The cross-border spillovers for output of a VAT cut (see Figures 3.10 to 3.12) are stronger when the cut is implemented in the larger country because the deflationary effect is stronger (nearly a 1-point higher deviation of output 2 from the steady-state level). The size effect is indeed at play. Additionally, should the small country be more flexible, it is apt to become cost-competitive than the large economy and benefit even more from the spillover. Moreover, if the small country is flexible, the trade-off between savings and consumption for its government is tempered by the steeper deflation path. In the short run (about two years), public consumption deviates positively from the steady state, whereas the deviation is negative otherwise (the real interest rate channel).

The cross-border effects of a cut in the payroll tax (see Figures A-3 to A-5 in the Appendix) are similar to those of a VAT cut. The effect on prices is weaker as there is no direct nominal pass-through, and the reaction of the central bank is thus more muted. Spillover effects are again larger when the cut is made in the large country because the small country exports a larger share of its production. Should the large country be less flexible, it generates half as much disinflation and puts less pressure on the central banker, which is less beneficial to the smaller country.

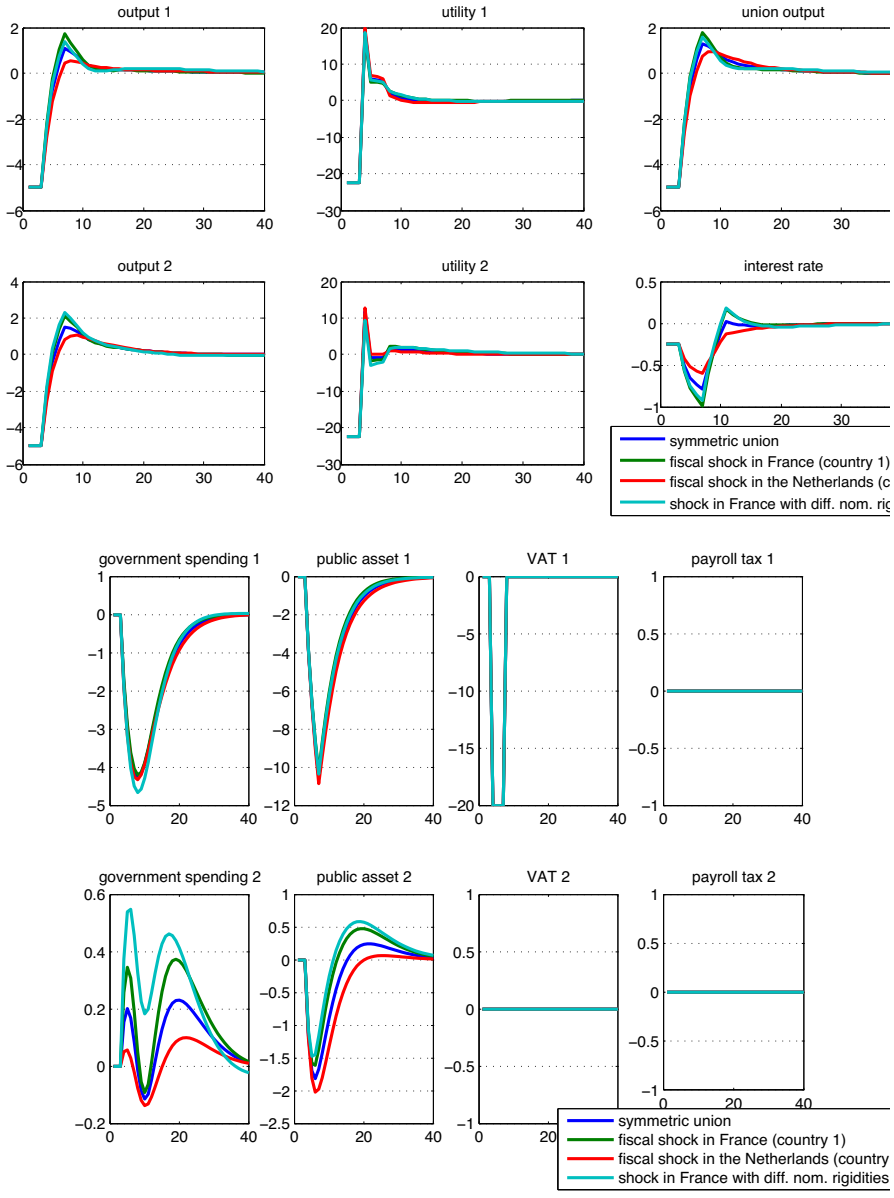


Figure 3.10: Effects and spillovers of a VAT cut – 1 of 3

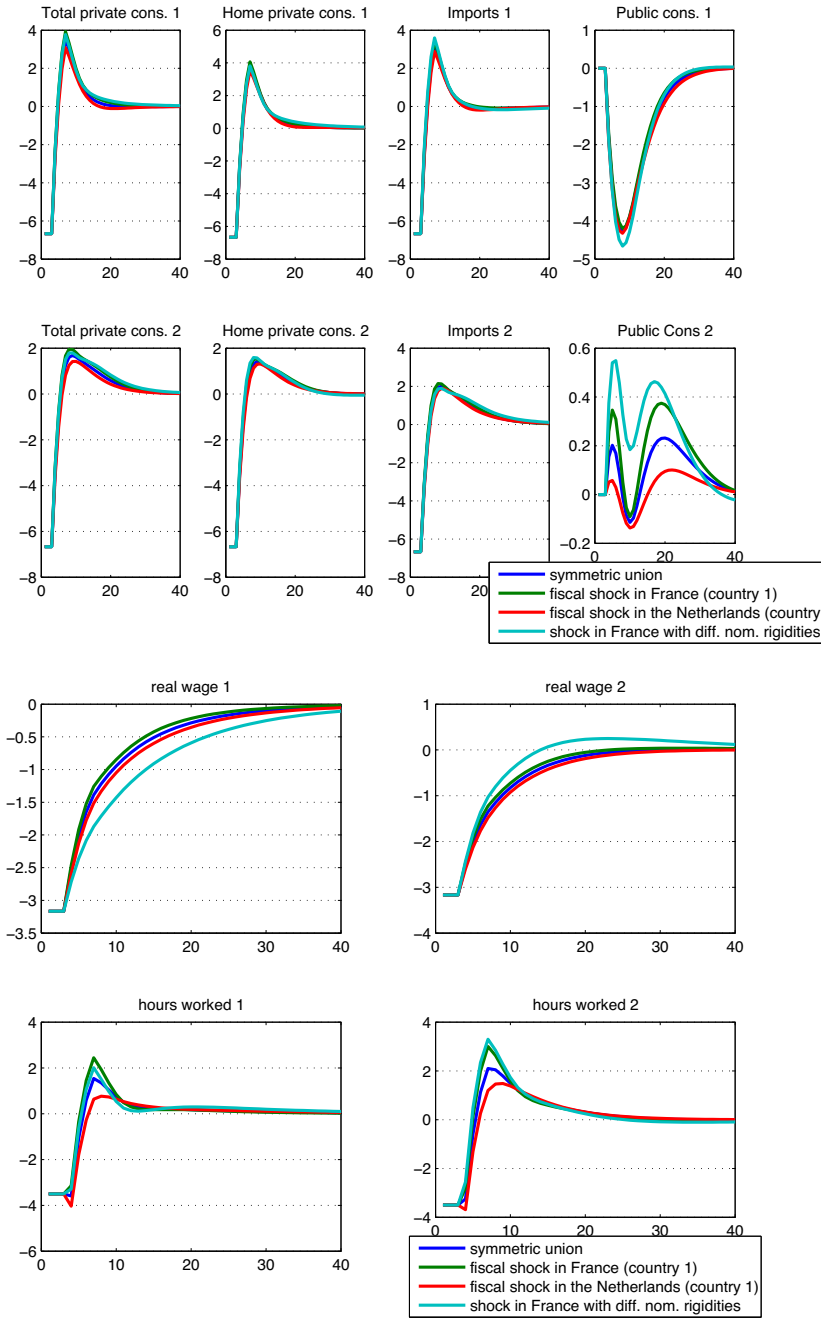


Figure 3.11: Effects and spillovers of a VAT cut – 2 of 3

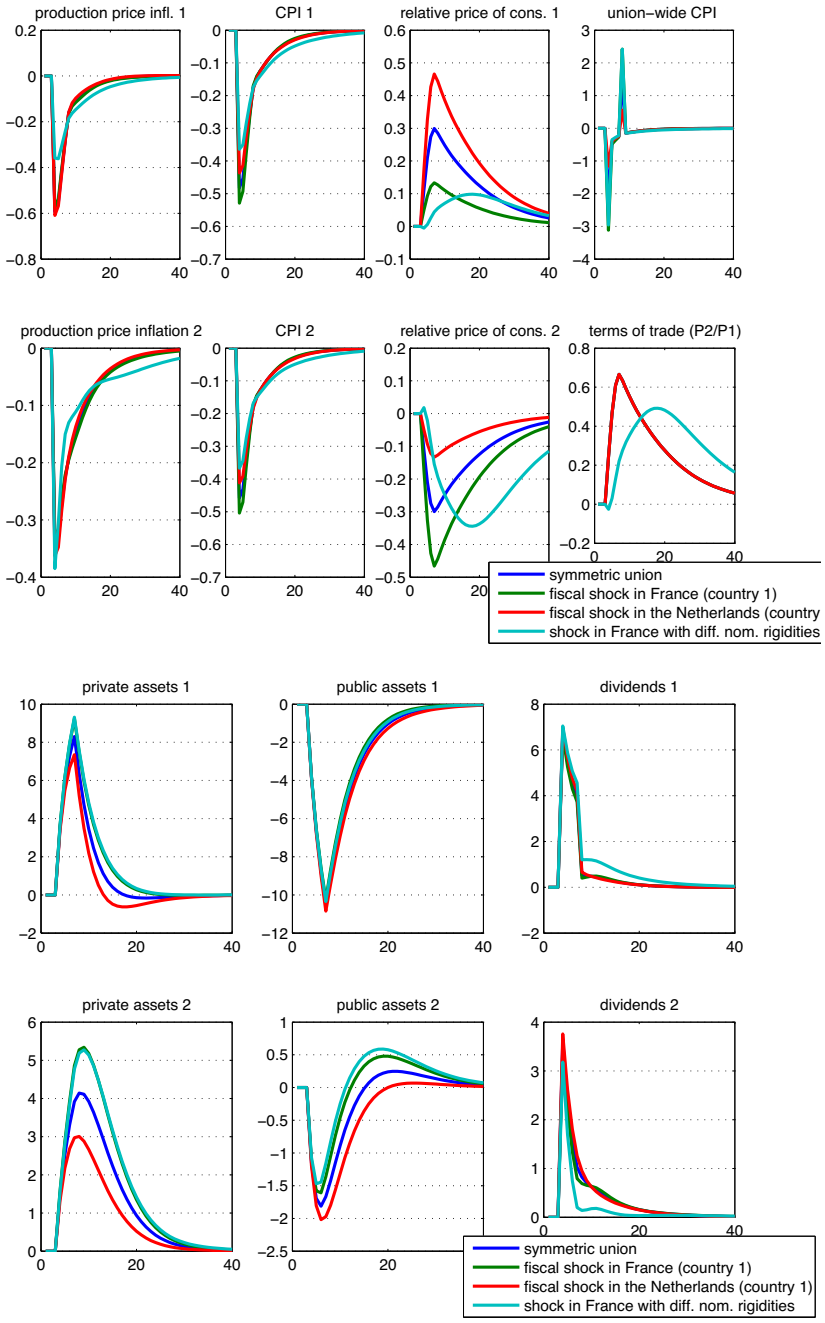


Figure 3.12: Effects and spillovers of a VAT cut – 3 of 3

3.4 Internal Devaluation in a Monetary Union

Calmfors (1998) argued that countries competing in a monetary union should engage in internal devaluation policies so as to regain lost competitiveness without jeopardising the stability of the currency area. The issue regained momentum with the 2009-11 Greek and Irish crises and the turmoil that ensued in peripheral eurozone countries faced with higher bond spreads over Germany. Without the ability to devaluate and thereby inflate away public debt, real depreciation can be achieved in a monetary union through a combination of higher taxes on consumption (to make imports more costly), lower payroll taxes and wage moderation (to decrease labour costs). Calmfors (1998) described it as a policy aimed at decreasing labour costs in real terms. To this aim, fiscal policy (also encompassing tax policy) should take up the function of "switching expenditures between foreign and domestic output, just as an exchange-rate change does". By this token, a cut in the employers' payroll tax would decrease labour costs, and thus, affect exports, output and employment like a currency devaluation would. The loss in government income (from the tax cut) can be recovered by an increase in other taxes, such as the VAT. To a certain extent, Germany followed this strategy in the 2000s and made great gains in terms of labour unit-costs compared to its neighbours[10]. Embattled peripheral economies of the eurozone have been emulating this strategy to regain export competitiveness. For instance, Greece and Portugal have increased their VAT rate in 2009-2010, frozen increases in civil servants' paychecks and encouraged wage moderation in export-oriented industries. The "Euro Plus" or "Competitiveness Pact" for the eurozone tentatively launched by Germany and France in 2011 also advocated wage moderation.

3.4.1 Internal Devaluation in a Symmetric Union

The main problem with such an economic policy (consisting of wage moderation coupled with fiscal austerity) is that it shifts national economies away from domestic demand, a recurrent problem in Germany in the 2000s, for instance. However, if all eurozone members, which trade intensively with one another, followed suit, this could trigger a cross-country drop in aggregate demand i.e. a beggar-thy-neighbour situation. One could therefore argue that internal devaluation is a supply-side response to a crisis that could be detrimental to demand in the eurozone because Member States trade primarily within the monetary union. It is thus relevant to evaluate whether the benefits of such an

[10] According to European Commission estimates, unit-labour costs in Germany fell to 15% below the eurozone average between 1999 and 2009.

economic strategy outweigh its costs and actually provide a viable way out of a crisis. In Figures 3.13 to 3.15, we compare the effects of a simultaneous hike of the VAT rate of about 5 percentage points and a drop of the payroll tax of 4 percentage points in country 1 after a global crisis (as previously, GDP in both countries falls by 5%). Both measures are worth 3% of GDP and thus cancel out in the government budget. We compare this internal devaluation policy to the four fiscal policy alternatives presented previously.

By resorting to internal devaluation, country 1 succeeds in boosting its output and consumption by 0.3% more than with simple tax cuts, but less than with public spending. The effect on domestic public finance is mild because the cut in the labour tax is financed through the VAT increase, and public assets go up. The government is able to engage in fiscal consolidation because, on one hand, the tax intake is fostered by the VAT increase, and on the other hand, the cut in the payroll tax makes firms in country 1 more competitive (the real wage remains below its steady-state level), so they hire and produce more and, consequently, end up contributing more to the tax intake. From this perspective, internal devaluation seems an appropriate option to stimulate demand while abiding by the SGP deficit limit. The positive spillover it generates on the output of country 2 is in line with those of traditional fiscal measures (+0.3% in comparison with the passive government scenario). However, on inspection of the cross-country spillovers, internal devaluation appears detrimental to the public finances of the foreign country: the government of the foreign country has to face an adverse competitiveness shock which translates into a higher public debt level than the one induced by the other policies (+0.5% of induced debt than for other measures on average). As foreign labour and consumption decrease, the foreign government must make up for lost tax intakes and keep its debt level in check by lowering public expenditure. The terms of trade are this time in favour of country 2 and mitigate the negative spillovers through increased exports. Indeed, holding the costs of fiscal measures constant, relative prices are more sensitive to VAT than to payroll tax fluctuations. Internal devaluation prompts a rise in the nominal interest rate as an initial reaction to the inflationary increase in VAT. As a consequence consumption is adversely affected in both countries (though not more than in the case of other policies), and governments consolidate their public finances, which triggers the later interest-rate cut by the central bank.

The difference between the traditional fiscal stimuli we analysed in the previous sections and internal devaluation in terms of spillovers is not clear-cut in a symmetric monetary union. From a demand-side perspective, this strategy does not outperform fiscal expansion. However, in this case, the dynamics and repartition of public and private

assets are different. The government of the foreign country bears a larger cost associated with its neighbour's policy with plummetting public assets.

Let us now see how the repartition and scope of spillovers differ in an asymmetric monetary union.

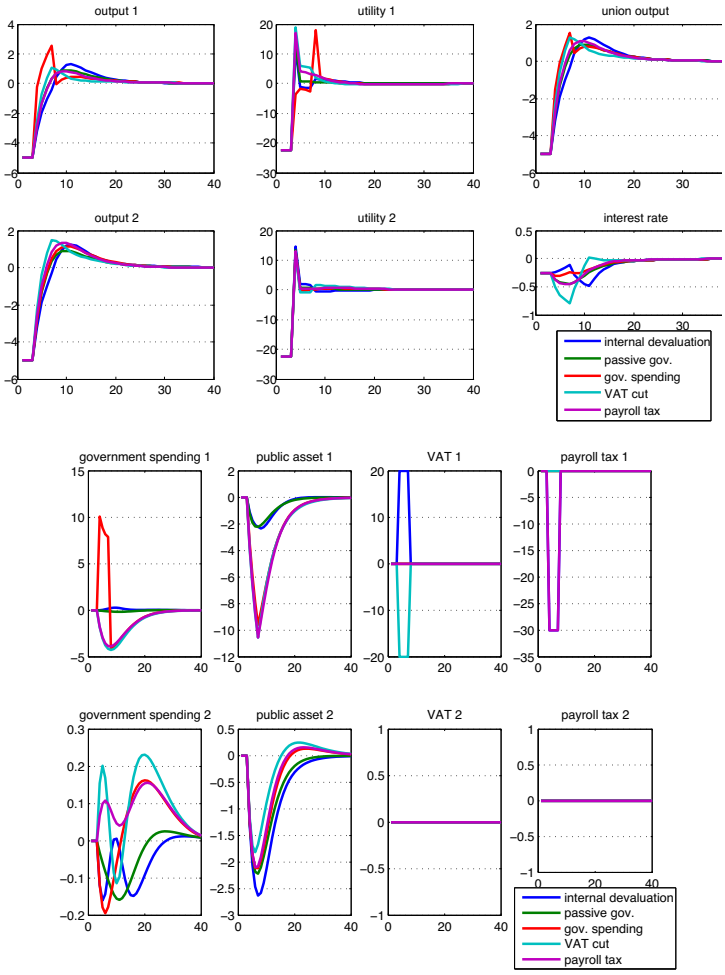


Figure 3.13: Internal devaluation in country 1 – 1 of 3

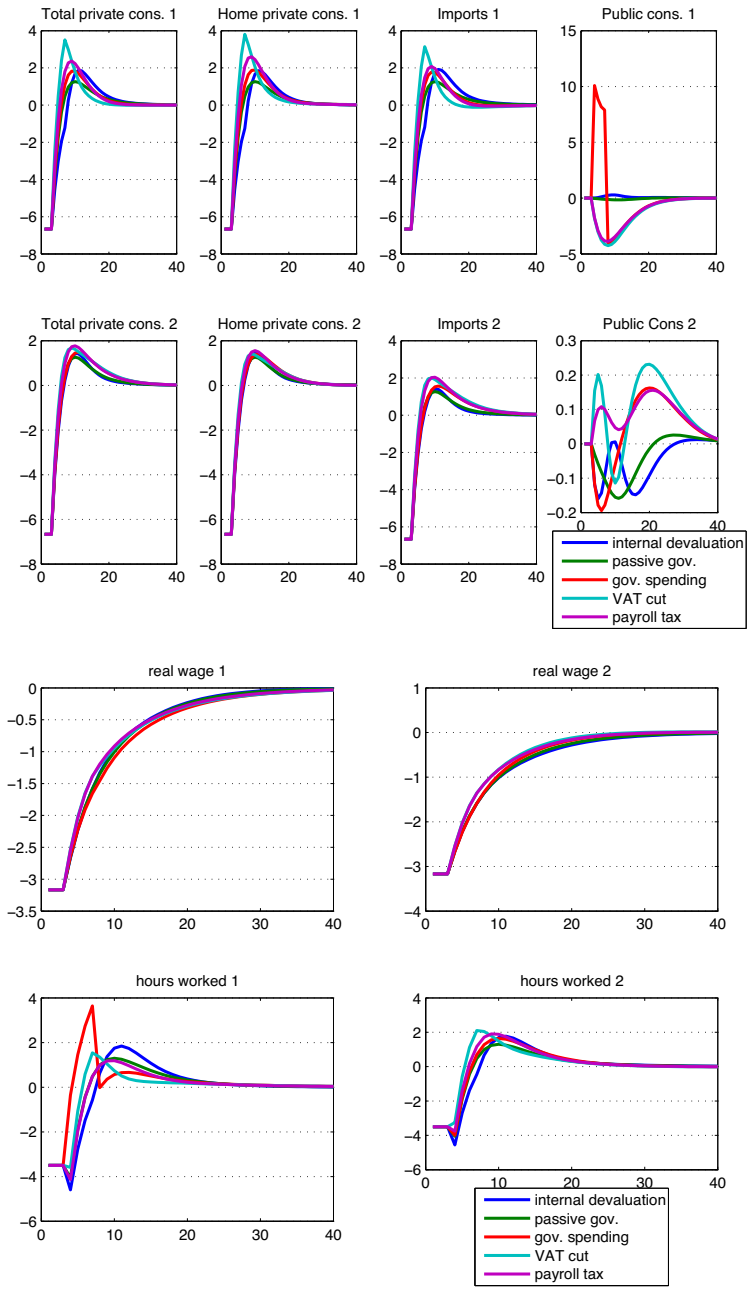


Figure 3.14: Internal devaluation in country 1 – 2 of 3

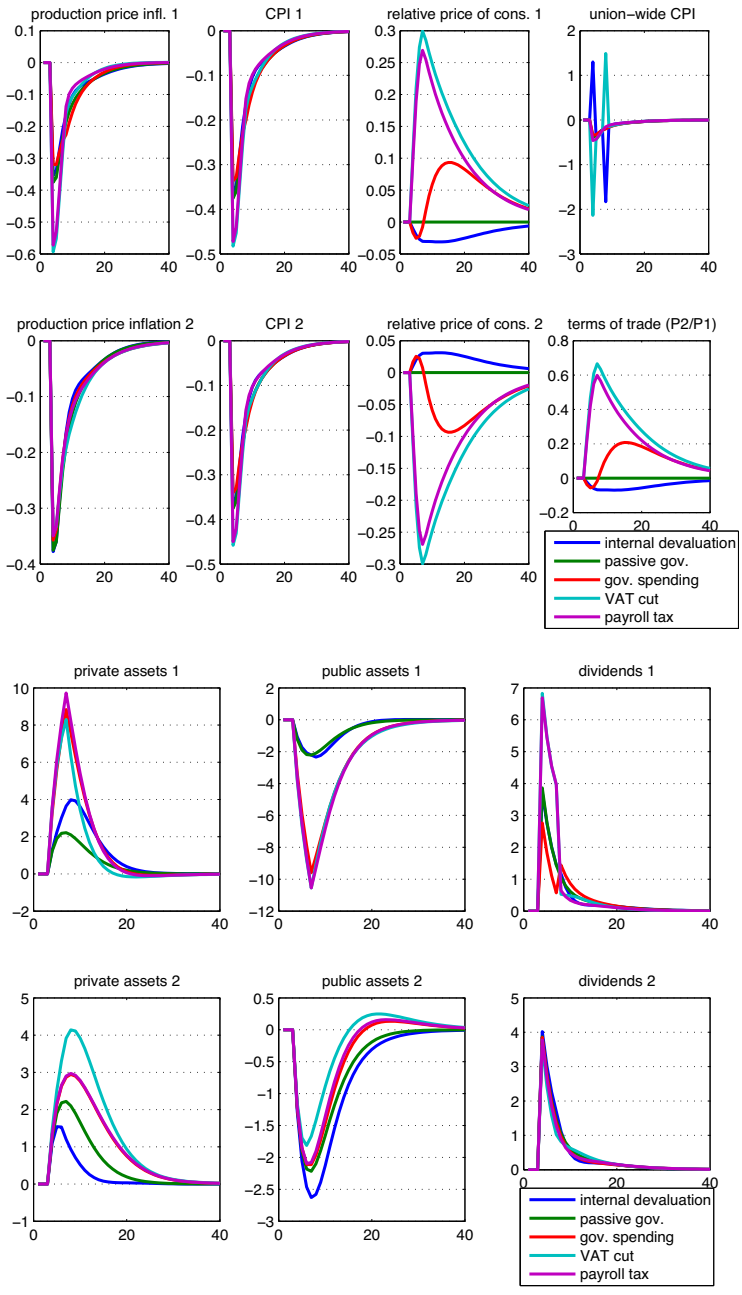


Figure 3.15: Internal devaluation in country 1 – 3 of 3

3.4.2 A Stay-In Strategy for Small Countries?

We now investigate which type of country should undertake internal devaluation, and consider whether it is an appropriate stay-in strategy for small ailing peripheral countries to gain back competitiveness and alleviate sovereign financing concerns. In Figure 3.16, we compare the effect of internal devaluation on output variables when it is undertaken by a small open economy (upper graphs) or by a large closed one (lower graphs). In an asymmetric monetary union (we apply the same size and openness degree as in the previous sections), internal devaluation proves an efficient policy measure for a small open economy. The benefits in terms of output are only second to those of the public spending option, while the costs are lower. Also it exerts slightly larger positive spillovers on the foreign country as the VAT increase shifts consumption from home production towards imports.

Conversely for a larger and more closed country, the benefits associated with internal devaluation in terms of output and consumption are smaller than a those of a public spending increase or VAT cut. In this respect, internal devaluation is less attractive than in a symmetric monetary union setting. By the sheer country-size effect, the spillovers on foreign output and consumption are barely larger than in the case of a passive government. Looking at the evolution of total union output gives a clear ranking: government spending yields the largest boost to output when countries are symmetric or when the larger one implements the fiscal measure. Internal devaluation is best for the union as a whole, when the onus is on the small country to take action. Internal devaluation is a supply-side policy with externalities on public debt. It thus seems a reasonable stay-in policy for regaining competitiveness and avoid the deterioration of public finance figures provided the country implementing it is relatively a small and open.

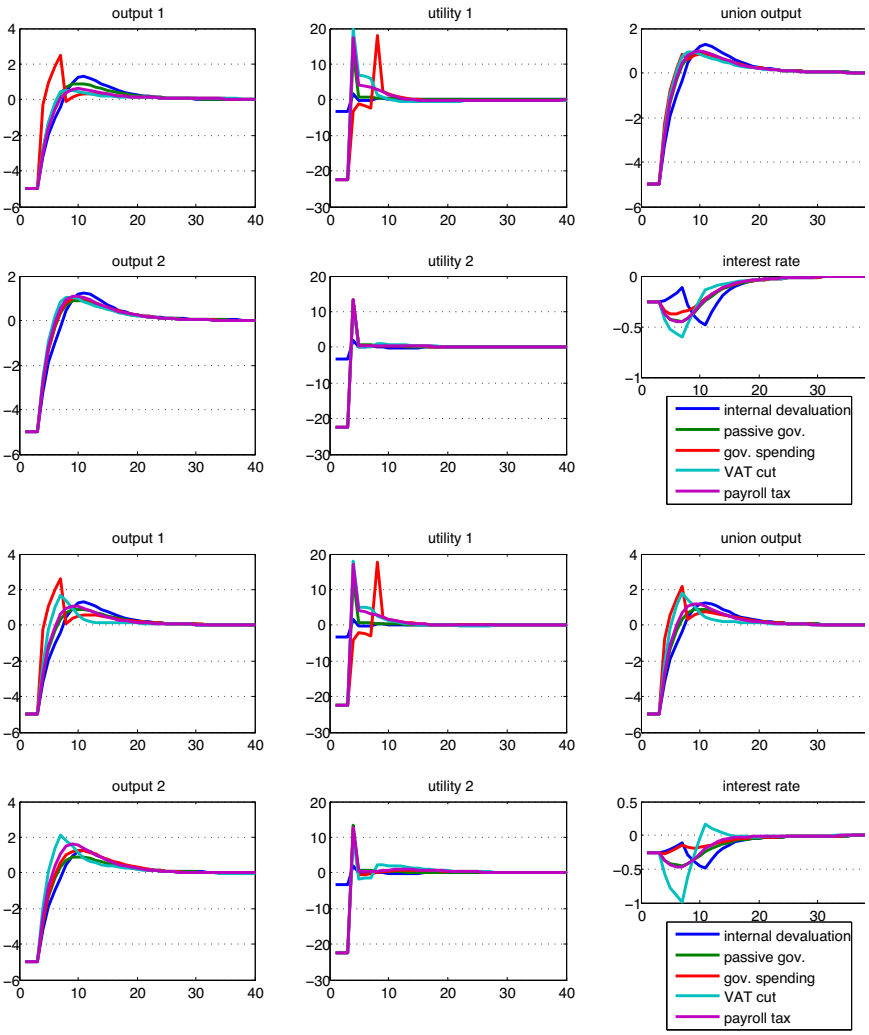


Figure 3.16: Internal devaluation undertaken by a small (above) vs. large (below) country

Conclusion

What type of fiscal policies cushion best a monetary union economy hit by a crisis? What are the spillovers of these policies, and to what extent do they depend on asymmetries between Member States? After a loss in competitiveness, what are the alternatives to a currency devaluation? To answer these questions, we developed a micro-founded dynamic model of a two-country monetary union with public debt to include the main features of the EMU. We relied on deterministic simulations to further the understanding of the workings of heterogeneous monetary unions, fiscal externalities and their implications for national economic policies. Country size is an important aspect of the analysis: because large economies rely more on domestic demand than small and open ones do, they react differently to fiscal stimuli.

Comparing fiscal policies, in the wake of a crisis, an increase in government spending better remedies the drop in consumption and output than VAT or payroll tax cuts do. We find that, starting from a recession scenario, fiscal policy can be counter-cyclical, with non-negligible multipliers even with forward-looking agents. These results are robust to alternative parameterisation and modelling of government spending behaviour. The cross-border effect of fiscal expansion is always positive. Spillovers can be considerable (up to $+1\%$ deviation from steady state for foreign output), especially when countries differ in terms of size and openness and expansion is undertaken in the large country. Conversely, asymmetries in nominal rigidities have a weaker impact on the size of fiscal spillovers. However there is a strategic asymmetry between the country undertaking the policy and its neighbour: the home country benefits more from an increase in public spending in terms of output and consumption, while its partner benefits from larger positive spillover effects in the case of tax cuts.

We have looked into the effects of internal devaluation policies, combining an increase in the VAT with a decrease in the payroll tax to sharpen the price-competitiveness of production. The boost to domestic consumption is lower than with an increase in government spending but larger than in the case of a tax cut. This supply-side policy proves conducive to public finance consolidation in the home country. However, public finances of the foreign country are more negatively affected by this policy than by other fiscal measures. Implementing internal devaluation may thus be worth considering when small, open countries face supply-side problems coupled with high public debt. The unfolding of the eurozone sovereign debt crisis makes further research in this area all the more relevant.

4 Country Size, Economic Performance and Volatility

with Paul Hubert

Abstract

What are the relationships between country size, growth and business cycle volatility? To investigate this question, previously asked by Rose (2006) and Furceri and Karras (2007), we developed an original country-size index with principal component analysis (PCA). Traditional analysis of this topic usually equates country size with population. Our methodology enables us to simultaneously consider several factors determining constitutive of country size: population, GDP and arable land. The inclusion of these additional variables allows us to analyse different components of country size and to control for more than a merely demographic effect. Using a panel data set of 163 countries for 1960–2007, we find, contrary to Rose (2006), that country size has a significant and negative correlation with economic performance. Our results for output volatility extend the negative and significant relationship found by Furceri and Karras (2007). In addition, we present differentiated results for small and large countries, OECD members, eurozone countries and the so-called BRIC countries. These results are robust for different country and time samples and several control sets.

Introduction

Does the size of a country influence the pace and volatility of its growth? The existence of a so-called "scale effect" on economic growth is a recurring question in economics. The answer to the first part of this question seems to depend on the economic context and phenomena of the time. The impressive development of small East Asian economies in the 1970s and 1980s was hailed by the motto "small is beautiful" and fuelled a new branch of literature documenting these economic miracles. The latest fad in the field of

economic growth describes the success of the BRICs (Brazil, Russia, India and China), i.e., a new type of rapidly growing juggernauts in the world economy. Different aspects of a country's size may impact positively or negatively on its growth as shows the work of Alesina, Spolaore, and Wacziarg (2005) on the costs and benefits of size. The first question addressed by this research is whether some endowments and characteristics linked to size outweigh the others. For instance, a large land area is prone to provide more natural resources but may also prove difficult and costly to manage for public services and transportation means. Likewise, a large population provides labour force and a wide domestic market with scale economies but may incur larger administrative costs if it is heterogeneous. A high GDP may be associated with slower growth rates as income and development levels are already high, but also with better infrastructure, greater human capital and so a higher growth potential. In this paper, our aim is to test whether we can indeed point out a relationship between size and GDP growth rates at the cross-country level.

The relationship between country size and volatility is more clear-cut. Intuitively, small and very open economies should be more sensitive to abrupt business cycle fluctuations, incurred for instance, by changes in terms of trade or in capital flows. These countries cannot rely on a large domestic market to even out economic turbulences. Thus, our second research question is whether, we can confirm empirically that GDP growth volatility and the size of a country are negatively related.

Let us first define "country size". One way of understanding the size of a country that is often used in economics is to consider that, in the world economy, small countries are price takers, whereas large ones are price makers. As Salvatore (2001) notes, however, this definition does not always hold; some small countries may be price makers if there is a limited number of suppliers. Ivory Coast and Ghana, for example, affect the price of cocoa. In addition, country size includes several dimensions: political, economic, geographic and demographic. The political dimension of country size, including the weight and power of countries in international institutions is obviously important, but difficult to quantify. GDP is easily quantifiable and makes rankings based on economic size straightforward, but in regressions analysing growth determinants, it causes endogeneity problems. The geographic dimension of country size bears the least clear-cut relationship to the other variables, as a large population may densely occupy a small territory and vice versa. Such cases include the Netherlands on one side and Russia or Australia on the other. Population provides the easiest proxy for country size and has been widely used as such. Several authors, including (Kuznets (1960), Demas (1965), Salvatore (2001) and

Lloyd and Sundrum (1982)), use arbitrary demographic limits to differentiate between small and large countries.

Relying also on population as a proxy for size, Rose (2006), searching for this "scale effect", finds no relationship between country size and growth. He only confirms the higher degree of openness of small countries, which had also been documented by Rodrik (1998) and Alesina, Spolaore, and Wacziarg (2005). The multiplication of the number of independent countries from 51 in 1945 to 195 today in 2010, notwithstanding the political reasons behind state creation, suggests that small countries may be more viable in a globalised world economy with liberalised international trade. Trade-openness is certainly one of the links between country size and business cycle volatility. Furceri and Karras (2007) document a clear inverse relationship between country size and volatility and Furceri and Karras (2008b) show it holds, focusing only on the OECD countries.

Our contribution to the literature is to develop an original measure of country size: a multidimensional index of size generated using principal component analysis (PCA) that includes population, GDP and arable land. This indicator enables us to avoid the shortcomings of either a purely demographic measure or one based on GDP rankings. This *PCA Size index* captures the underlying patterns between three important components of country size: population, GDP and arable land. The interactions of each of these variables on growth are presumably complex and not exclusively related to size. Instead of including them individually in our regressions,our PCA index serves as a proxy for country size. By construction, it captures the common variation of the three size components and so increases the likelihood that we focus on the size factor and do not pick up "parasite" effects. We may thus provide a richer analysis of the relationships between country size and economic performance and business cycle volatility. To make our work more easily comparable with previous studies, we also conduct our analysis using population as a proxy for country size. We also use this as a robustness test for our results.

We then proceed to the empirical investigation of the relationship between country size and short-term growth and its volatility for 163 countries over 1960–2007. We rely on a multivariate panel regression analysis to assess the direct and indirect effects of country size on economic performance. Indirect effects can be caused by volatility. In our analysis, we also isolate the scale or country-size effect from those of several economic variables, especially that of trade openness. Our empirical findings suggest that over 1960–2007, for the whole panel, there is a negative relationship between economic performance and size (contradicting Rose (2006)). This relationship is more marked for

certain groups (small countries, OECD and BRICs) and opposite for eurozone countries underlying the specificities of the European integration. We then show that there is a negative relationship between country size and business cycle volatility independent of trade openness, extending Furceri and Karras's results, especially for small countries. A complementary finding of our analysis is that trade is a strong positive determinant of GDP growth but not of its volatility. Our results are robust to the inclusion of several control sets, country size specifications and detrending methods.

The remainder of this paper is organised as follows. We sum up relevant theoretical considerations in Section 2. Section 3 presents our empirical methodology, the construction of our country-size index, volatility measures and estimation strategy. In Sections 4 and 5, we interpret our results with regard to existing theories for the relationship between country size on growth and growth volatility , respectively, before concluding.

4.1 Theoretical Considerations

What may account for the non-neutrality of country size with respect to GDP growth and cyclical volatility? Country size encompasses a number of dimensions and so, as shown by Alesina, Spolaore, and Wacziarg (2005), costs and benefits associated with it are diverse. As, we mentioned, a large area may provide more natural resources but also incur larger transportation and management costs. A large population may swell the ranks of human capital but also the food and administration needs for instance , explaining fertility control policies in developing economies. A large GDP hints at the fact that a country may be close to its steady-state and will thus witness a slower pace of growth, or the other way around, that it possesses a capital or technology-intensive industrial base capable to generate endogenous growth.

In a closed-economy neoclassical growth framework, like that used by Solow (1956), country size – usuallly captured by population or endowment size – has indeed no effect on growth. Supposing increasing returns to scale, however, Rodrik (1998) showed that because of scale effects and the larger resources at their disposal, large countries are more efficient in the provision of public goods. Milner and Weyman-Jones (2003) also empirically documented that smallness was a hurdle for efficient economic development in developing countries over the 1980–1989 period. In an endogenous growth model, like that described by Aghion and Howitt (1998)), a larger country size means a large endowment and scale effects drive economic growth. The argument is straightforward; the larger the country, the larger its workforce and resources – especially in terms of

human capital and R&D – to be engaged in industries with increasing returns to scale. This also implies a larger domestic market to sustain growth and that the aggregate catch-up will be quicker. Conversely, Kuznets (1960) and Lloyd and Sundrum (1982) underlined that the concentration of output in a few industries and commodities, and the limited scope of national industries and agricultural markets, weakened growth in small economies. Regarding the ability to borrow in its own currency on international markets, Eichengreen, Hausmann, and Panizza (2003) noted that very large countries may be the only emerging economies able to escape from the "original sin". The high growth rates displayed by China and other BRICs in the 2000s empirically suggest the existence of a "scale effect" for growth in a liberalised economic context.

Another theoretical question of relevance for our analysis is whether small economies tend to benefit more from trade. In an open-economy framework, Mill's (1844) reciprocal demand theory already hinted at the larger gains made by small countries in international trade. These gains are proportional both to the unsatisfied internal demand in autarky and to the external demand addressed to them. Katzenstein (1985) and Schiff (1996) confirmed that "small nations obtain greater gains per unit of international trade than do large nations"(Lloyd (1968)) and also highlighted that small countries reap greater benefits from preferential trade agreements and greater integration of international markets. The multiplication of the number of independent countries from 51 in 1945 to 195 today in 2010, notwithstanding the political reasons behind state creation, suggests that small countries may be more viable in a globalised world economy with liberalised international trade. Alesina, Spolaore, and Wacziarg (2005), show that in this context benefit more, in relative terms, from openness to trade than do large countries. Following Verdoorn's law export-led growth increases the productivity of the tradable sector and so its international competitiveness, fuelling smaller more open economies' GDP growth.

Beyond trade openness the relative internal efficiency of small and large countries may also account for the discrepancies observed in their growth rates. Robinson (1960) conducted a detailed analysis of the "economic consequences of the size of nations" and suggested that the adaptive capacities of small economies and their higher degree of homogeneity can help overcome the narrowness of their domestic markets. This may also be grounded in the more physical dimensions of a countries economic structures. Countries are a collection of regions with different growth rates, one could argue that because of diseconomies of scale in managing larger territories and more numerous administrative entities, larger countries will have a higher proportion of slower-growing

regions than smaller countries, hence their lower average national growth rates. In the subsequent chapter this territorial efficiency aspect is the object of further analysis.

Regarding country size and volatility, the intuition that large countries will have more inertia in their growth rate and smaller ones, sharp fluctuations is theoretically substantiated. Imbs (2007) builds a theoretical model to explain the inverse relationship between country size and output volatility: the larger number of sectors present in the economies of large countries accounts for the lower volatility of output. Considering a large panel of countries, Easterly and Kraay (1999) found that the greater openness of smaller states induced both higher growth and higher volatility. The higher sensitivity to external shocks and greater volatility of small countries is a consequence of their more specialised economies. Indeed, large domestic markets mean that the covariance between world and domestic growth is higher, whereas small, specialised economies are more likely to face both idiosyncratic and common shocks. Using a real business cycle (RBC) model and Monte Carlo simulations, Crucini (1997) found that even after controlling for market structures and development levels (in terms of investment, savings, trade, and consumption), small economies experience higher output volatility than large ones. This phenomenon may also be linked to the relationship between openness and inflation; Romer (1993) found evidence for a higher trade-off between output and inflation in small and more open countries, as the real depreciation effect hinders monetary stabilisation. Furthering the argument made by Katzenstein (1985) that small states in world markets aim to achieve "domestic compensation". Furceri and Poplawski (2008) highlight an inverse relationship between country size and the volatility of government consumption. They suggest that this is a consequence of higher exposure to external shocks. Similarly, Rodrik (1998) argues that governments play an income-stabilising role in the face of global uncertainties. This "exposure mitigation" mechanism explains why more open economies tend to have larger governments. Finally, it may be asked whether volatility hurts growth in the long run; Aghion and Banerjee (2005) and Ramey and Ramey (1995) contend that it does.

The economic rationalisation of an absolute size effect on either real GDP growth or growth volatility is therefore *a priori* not clear-cut and remains an open empirical question.

4.2 Empirical Methodology

4.2.1 Data

Our data set includes the 163 countries for which the relevant annual data series, i.e., GDP, population and arable land, were available[1] for the 1960–2007 period.[2] Our computation of output volatility measures required a complete data set over the 1960–2007 time span, hence the exclusion of countries with interrupted GDP series (Fiji, Kuwait, Libya, Myanmar and Somalia). We interpret our results bearing in mind this possible "survivor bias"; however, the list of countries in our panel is comparable to those of our main references Rose (2006) and Furceri and Karras (2007).[3] We rely on annual data and decade averages of volatility indicators.

Turning to the data, our explained variable is either the GDP growth rate (%) or a measure of output volatility computed using GDP levels ($ 2000 constant).[4] Explanatory variables include three possible measures of country size, detailed below, among which population (millions) is measured in logarithm to test for a proportional (and not linear) correlation. Standard economic variables are included as controls: trade openness, measured by the ratio of the sum of the values of exports and imports divided by GDP; inflation (%).(Descriptive statistics of our dataset are in Table B-3 in the Appendix.)

4.2.2 An Original Index of Country Size

Our contribution lies in the country size index we developed using PCA. In their analysis of the interaction between country size, trade and growth, Alesina, Spolaore, and Wacziarg (2005) take alternatively population and GDP as a proxy for country size in

[1] Our data source is the World Bank. Our panel included 177 countries , but the data on the GDP, population and arable land to compute our PCA size index and Jalan's size index were only available for 163 countries (listed in Table B-1 in the Appendix). We included the additional 14 countries in the regressions with population as a proxy for country size to test for the robustness of our results across size indicators.

[2] For the sake of precision, there are 195 sovereign states in the world, 192 of which are United Nations members. The 2009 CIA World Factbook lists 245 entities, including 195 "politically organized into a sovereign state with a definite territory" and 54 dependencies and areas of special sovereignty affiliated with another country.

[3] Rose (2006) lists 208 "countries" but refers to them as "populations" because of the inclusion of a number of micro states and islands. The data set used by Furceri and Karras (2007) include 167 countries.

[4] Our focus is to explain the effect of size on the pace of growth of countries not on their wealth or on the income level of its inhabitants. Thus, taking GDP per capita by normalising GDP with respect to demographic size would make our analysis meaningless. GDP per capita as a dependent variable would endogenise country size and lead to spurious econometric results, as both sides of our equation would include the effect of size. By the same token, GDP per capita is a proxy for the wealth of a country, not its size and so does not qualify an appropriate component for our PCA size index.

their regressions. However, we want to pinpoint a more global "size effect", not just a population of GDP effect. The *PCA Size index* captures the underlying patterns between three important components of country size: population, GDP and arable land. It is therefore a more complete indicator of country size and so avoids the shortcomings of either a purely demographic measure or one based on GDP rankings. The interactions of each of these variables on growth are presumably complex and not exclusively related to size. Instead of including them individually in our regressions,our PCA index serves as a proxy for country size. By construction, it captures the common variation of the three size components and so increases the likelihood that we focus on the size factor and do not pick up "parasite" effects. This size index is therefore better suited to assess properly the unique and overall effect of size on GDP growth and its volatility. For the purpose of comparability with other studies and robustness, we test the log of population as a proxy for country size in our estimation procedure. We also use the country size index developed by Jalan (1982). We run our analysis using his measure because to substantiate the claim that country size encompasses more than just demographic dimensions. Jalan's index is a weighted average of demographic (population), territorial (arable land) and economic (GDP) sizes. Each component is measured against the largest value of the sample in a given year. Indeed, country size should be understood in relative terms as countries are categorised as small or large only in comparison with others. *Jalan's size index* is computed as follows:

$$Size\ Index_{it} = \frac{100}{3}\left(\frac{Population_{it}}{Max\ Population_{t}} + \frac{Arable\ Land_{it}}{Max\ Arable\ Land_{t}} + \frac{GDP_{it}}{Max\ GDP_{t}}\right)$$

This index, therefore, takes values in $[0;100]$. Assessing country size this way is sometimes problematic, as Jalan's size index allows for linear compensation across size dimensions; for instance, a country with a very large territory but small population and economy may qualify as large, even when it would intuitively never be described as such.

We overcome the linearity problem by relying on our own country size index. We use PCA to account for the demographic, economic and geographical dimensions of country size. PCA can be interpreted as a fixed effects factor analysis, as it enables us to identify patterns in the data and emphasise their common trends. We take the three country-size variables in log because we assume they are linked proportionally (not linearly) and that they are not originally expressed in commensurable units. Whereas PCA, as a linear transformation of the data, does not require the compliance of the data with a given statistical model, the high correlation of our variables as shown in Table 4.1 makes

resorting to PCA sensible.[5] PCA performs an eigen decomposition of the correlation

Table 4.1: Correlation table of our three variables of interest for the size

Variable	Population, log	GDP, log	Arable land, log
Population, log	1		
GDP, log	0.77	1	
Arable land, log	0.81	0.54	1

matrix. We chose to retain only the first component, the only one that has an eigenvalue over one. This unit-length linear combination of the variables contains maximal variance, i.e., 83% of the common variance, as detailed in Table 4.2, minimising information loss. Thus, the *PCA Size index* we compute allows us to operate a practical data reduction of three variables into one. The index is generated for each country in a given year, has a mean of zero, and is expressed in terms of the contributions of population, GDP, and arable land to country size. This also makes subsequent interpretation simpler; our *PCA Size index* captures the internal structure linking the three variables. If one of the variables departs from the overall pattern linking it to the other two, it will be assigned a lower weight. The loadings (see the component column in Table 4.2) that relate the observed data to the components in the eigenvectors are roughly equal so that the three components of our PCA index have a similar role in capturing country size. Data to carry out such a construction was available for 163 countries.

Table 4.2: Detailing our principal component analysis

Principal Component Analysis				
Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.493	2.100	0.831	0.831
Comp2	0.393	0.279	0.131	0.962
Comp3	0.114	0.000	0.038	1.000
Principal components (eigenvectors) – Scoring coefficients				
Variable	Comp1	Unexplained		
Lgdp	0.550	0.247		
Lpop	0.609	0.076		
Lar_land	0.572	0.184		
Number of obs	163	Number of comp.	1	Trace = 3
Rotation:(unrotated = principal)		ρ = 0.831		

We consider a country to be large if its *PCA Size index* scores in the top 10 %, the others are considered small. For simplicity, we do not include a medium-sized category. In this

[5] Additionally, the Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy of 0.72 for the GDP component, 0.59 for population, 0.66 for arable land and 0.64 overall make our PCA size index statistically acceptable given the degree of commonality found in the data.

study, a country was considered large if the $PCASizeIndex > 1.9853$ (corresponding to the 90% percentile of the sample), and small if the $PCASizeIndex \leq 1.9853$. To get a better sense of what PCA scores capture, we summed up the qualifying thresholds for large countries according to population, GDP and arable land in Table 4.3.

Table 4.3: Thresholds for large countries

Index PCA	1.9853	Quantile 90%
Equivalent to	Population	49.22 millions
	GDP	315.96 billion $
	Arable Land	576.94 th. km^2

In our sample, 17 countries qualify as large and are listed in Table B-2 in the Appendix. An increase of one PCA unit corresponds, on average, either to an area wider of 244,000 km^2 (equivalent to the UK's area), a GDP greater of $151 billion (equivalent to Finland's GDP) or a population that has 31 million people (equivalent to Morocco's population) more.

4.2.3 Measuring Volatility

Following Furceri and Karras (2007), we compute the cyclical component of the business cycle volatility from the log of real GDP ($ 2000 constant, so as to neutralise inflation and exchange rate fluctuations) using the following techniques:

- (i) simple standard deviation (SD) of the GDP growth rate (decade averages), which yields the most volatile series;
- (ii) standard deviation of the cyclical component of the Hodrick-Prescott (HP) filter (highpass filter) applied to GDP in levels with a smoothing parameter set at 6.25 (as argued by Ravn and Uhlig (2002)) for annual data;
- (iii) standard deviation of the cyclical component of the Baxter-King (BP) filter (lowpass filter), which approximates a moving average of infinite order and drops data at both ends of the series with cut-offs at 2 and 8. The lead-lag length of the filter is set to 3.

4.2.4 Estimation Strategy

To estimate our model (see equation 4.1), we first checked for common statistical issues of panel data econometrics. Hausman tests run over the whole sample, and on different

country groupings (small, large, OECD, eurozone), indicated that the individual effects and our explanatory variables were systematically related, so that the fixed effects (FE, also called *within*) estimator was the most appropriate choice. As noted by Durlauf, Johnson, and Temple (2005), the FE estimator, which allows for varying intercept terms across countries, deals efficiently with unobserved heterogeneity, as time-invariant omitted variables do not bias the regression results.[6] This proves especially important when we use hard-to-measure or -quantify variables, such as political situation and institutions. An FE estimator has the advantage of controlling for different national effects of stable unobserved variables. The appropriateness of our FE estimation was also confirmed by an F-test for the significance of fixed effects. Running a Wald test for group-wise heteroscedasticity confirmed its presence in both data sets. Likewise, the Wooldridge test for autocorrelation in panel data indicated a first order correlation. In addition, following Drazen (2000), country size was assumed not to be an important source of endogeneity and so the IV estimator was not used.[7]

Heeding the results of these tests, we selected the FE estimator because it addresses all the statistical issues of our sample, including links between individual effects and regressors, heteroscedasticity and auto-correlation. We employed robust standard errors clustered at the country level because clustering at the panel data level produces consistent estimates of standard errors even in the presence of autocorrelation.

We estimate bivariate and multivariate models with a set of economic controls. *Controls or* Z_{it} are economic variables that are important in distinguishing country-size effects from other economic effects, including trade openness (as suggested by Rodrik (1998) and Alesina, Spolaore, and Wacziarg (2005)), the real interest rates and the inflation rates. Indeed, we want to isolate possible trade and price competitiveness effects from a country-size effect on growth and volatility. Furthermore, a theoretical justification for including inflation and interest rates as controls comes from the usual new-Keynesian IS curve:

$$x_t = -\frac{1}{\sigma}(i_t - E_t\pi_{t+1}) + E_t x_{t+1} + g_t,$$

where x_t is the output gap, σ is the inverse of intertemporal elasticity of substitution of private consumption, i_t is the nominal interest rate, $E_t\pi_{t+1}$ is the expexted inflation and g_t is a demand shock. We therefore try to isolate those effects of expected inflation

[6] Indeed, the within-estimator eliminates panel heterogeneity by demeaning variables and performing OLS on the generated data. This linear FE estimator is consistent, even when controls are correlated with the fixed effects.

[7] The Dickey-Fuller test indicated the absence of panel unit root, so that co-integration was not necessary.

(proxied by inflation in our regression) and the interest rate on GDP growth from those from country size.

In summary, we estimate the following regression model:

$$Y_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 Z_{it} + \beta_3 U_i + \epsilon_{it} \tag{4.1}$$

where

- Y_{it} stands for either GDP growth or a measure of output volatility (according to whether we are testing the relationship between country size and economic performance or volatility);
- $SIZE_{it}$ is a measure of country size (either our PCA size index, Jalan's index or population)
- Z_{it} is a set of economic variables (trade openness, real interest rate, inflation; all are expressed as percentages);
- U_i is the fixed- or country-effects term;
- and ϵ_{it} is the error term.

For each of our three estimations with the three size measures used, we run:

- a bivariate regression;
- a regression adding variable set Z_i;

for a total of six regressions for our FE estimations. The correlation structure of the variables is displayed in Table 4.4. The strong negative correlation between country size indicators, especially population and PCA size index, and trade openness confirms our intuition that small countries are more open than large ones.

4.3 Country Size and Growth

4.3.1 Preliminary Analysis

Before we detail our statistical results, we would like to illustrate an intuition for the relationship between country size (as measured by our PCA size index) and GDP growth for different groups with the scatter plots in Figure 4.1, 4.2, 4.3, and 4.4. When all countries of our data set are taken together (Figure 4.1), the flatness of the regression line indicates

Table 4.4: Correlation structure of variables

Variable	GDP growth	PCA size index	Jalan's size index	Population	Trade openess	Real interest rate	Inflation
GDP growth	1						
PCA size index	-0.04	1					
Jalan's size index	0.02	0.56	1				
Population, Log	-0.01	0.95	0.51	1			
Trade openness	0.13	-0.56	-0.33	-0.55	1		
Real interest rate, %	0.1	-0.04	-0.03	-0.05	-0.01	1	
Inflation, %	-0.08	0.02	-0.01	0.02	-0.02	-0.3	1

no clear relationship between country size and GDP growth as in Rose (2006). This somewhat blunt result of sample averages is to be qualified when we consider different country groups. For high-income countries (Figure 4.2), particularly in the eurozone

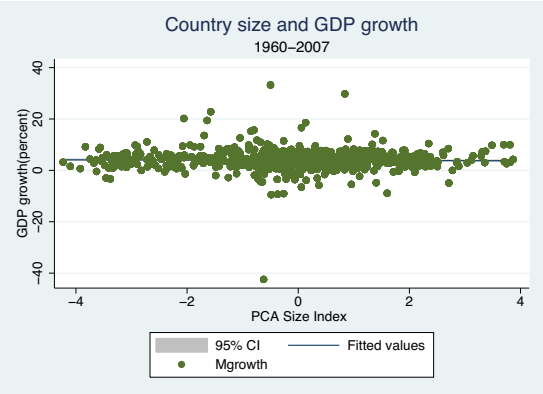


Figure 4.1: Country size and growth

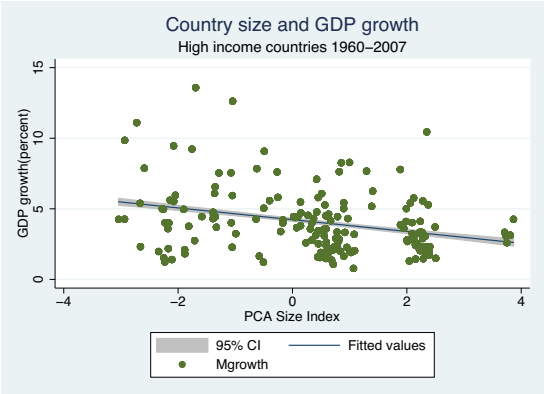


Figure 4.2: Country size and GDP growth in high income countries

(Figure 4.4), the bivariate plots show a negative correlation between how large a country is and by how much it grows. Conversely, for low-income countries (Figure 4.3) do not display a marked positive or negative correlation, so the level of economic development might be a driver of this inverse relationship.

4.3.2 Estimation Results

Table 4.5 displays the results of our FE regressions. Keeping in mind that our estimator controls for all stable national characteristics, both the PCA size index and population have negative and significant coefficients for all countries of the sample over the 1960–2007 period. As the PCA size index captures changes in population, GDP and arable land, these components are negatively correlated with the pace of growth. As a reminder,

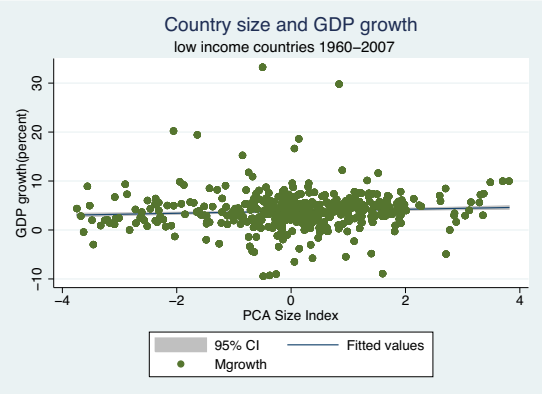


Figure 4.3: Country size and growth in low income countries

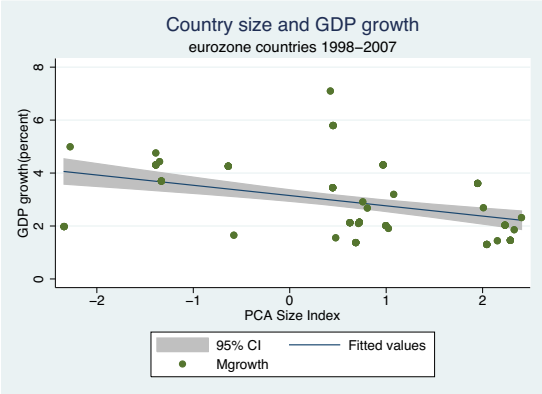


Figure 4.4: Country size and GDP growth in the eurozone

each additional unit in the PCA corresponds on average to either an area increase of 244,000 km^2, an increase in GDP of $151 billion or a population increase of 31 million. Because the coefficients measure semi-elasticities, we can compute precise quantitative correlations using the values of the standard deviations (see Table B-3 in the Appendix). For instance, a one-standard-deviation increase in population lowers the growth rate on impact by 2.6[8] change in the GDP growth over the whole period. The coefficient on Jalan's size index is comparatively small and not significant, confirming that the relationship between country size and growth is proportional and not linear. Following the values of the t-statistics, our results are more precise when economic controls are included in the regression, confirming their relevance in our analysis of a size effect on growth. The negative conditional correlation between growth and country size is indeed robust to the inclusion of economic variables. This means that we can identify a country-size effect on growth independent of the fact that small countries are, on average, more open. It is also worth noting that the coefficient of trade on GDP growth is very large and significant; 0.1 additional standard deviation of trade increases growth by 3.8%, confirming the vast body of literature on the benefits of trade that we quoted previously.

For small countries (which represent 90% of our sample), the results shown in Table 4.6 are similar. All country-size indicators concur first on the negative conditional correlation between country size and growth and second on the positive relationship trade openness and growth. Among large countries (listed in Table B-2 in the Appendix), there is no clear-cut relationship between size and performance.

[8]The effect on GDP growth of a one-standard-deviation increase in one of the control variable is computed as such: $\sigma_d epvar * coeff_d epvar / \sigma_g dpgrowth$.

Table 4.5: Country size and GDP growth – All countries, 1960–2007

Fixed Effects with correction for heteroscedasticity (cluster)						
	bivariate	controls	bivariate	controls	bivariate	controls
PCA Size index	-3.447***	-4.738*				
	[-6.01]	[-1.87]				
Jalan's Size index			0.494	0.346		
			[1.46]	[0.92]		
Population, log					-1.896***	-2.586***
					[-4.46]	[-3.09]
Trade Openness		5.297***		4.990***		5.456***
		[3.33]		[3.01]		[3.61]
Real Interest Rate, %		0.047***		0.044***		0.049***
		[3.15]		[2.95]		[3.11]
Inflation, %		-0.001		-0.001		-0.001
		[-0.89]		[-0.96]		[-0.95]
Constant	3.938***	0.190	3.583***	-0.601	7.061***	3.926**
	[809.67]	[0.13]	[16.00]	[-0.43]	[10.11]	[2.07]
N	6566	3237	6566	3237	6638	3273
R^2 within	0.012	0.047	0.000	0.041	0.007	0.047

t-statistics in brackets. * p<0.1, ** p<0.05, *** p < 0.01. Data source: World Bank.

Table 4.6: Country size and GDP growth – Small countries, 1960–2007

Fixed Effects with correction for heteroscedasticity (cluster)						
	bivariate	controls	bivariate	controls	bivariate	controls
PCA Size index	-3.467***	-4.604*				
	[-6.01]	[-1.68]				
Jalan's Size index			-1.901	-9.644*		
			[-0.74]	[-1.74]		
Population, log					-1.864***	-2.465***
					[-4.27]	[-2.90]
Trade Openness		5.533***		5.381***		5.758***
		[3.39]		[3.17]		[3.48]
Real Interest Rate, %		0.053***		0.051***		0.056***
		[3.66]		[3.51]		[3.68]
Inflation, %		-0.001		-0.001		-0.001
		[-0.79]		[-0.86]		[-0.82]
Constant	2.957***	-2.030*	4.352***	1.124	6.385***	2.192
	[18.56]	[-1.64]	[7.35]	[0.69]	[11.04]	[1.19]
N	5903	2815	5903	2815	5903	2815
R^2 within	0.012	0.053	0.000	0.050	0.007	0.054

t-statistics in brackets. * p<0.1, ** p<0.05, *** p < 0.01. Data source: World Bank.

Table 4.7 displays the results of our FE estimation for OECD countries (i.e. small and large rich countries). The conditional correlation between our PCA index and GDP growth is negative and significant but this is less so when economic controls are included. When country size is proxied by population, its relationship with GDP growth is negative and significant over the 1960–2007 time span. Indeed, among OECD countries with comparable development levels, heterogeneity in terms of population is much larger than in terms of GDP. The negative scale effect on growth seen here is most likely demographic. The correlation between growth and trade is not as strong as in previous cases, possibly because most of the OECD countries were already industrialised economies at the start of the period and did not use trade as a strategy to launch their economic take-off but rather as a tool for the continuation of their development. Economic performance appears to be better determined by cyclical factors, as indicated by the significance of the inflation and interest rates. More precisely, inflation is negatively associated with growth, confirming the importance of macroeconomic stability for growth as in Baldwin (2003). The real interest rate also has a negative correlation with growth, underlining the importance of the ease of obtaining credit for growth.

Table 4.7: Country size and GDP growth – OECD countries, 1960–2007

Fixed Effects with correction for heteroscedasticity (cluster)						
	bivariate	controls	bivariate	controls	bivariate	controls
PCA Size index	-5.271***	-4.077				
	[-3.30]	[-1.00]				
Jalan's Size index			0.687*	0.282		
			[1.97]	[1.06]		
Population, log					-5.441***	-12.59**
					[-4.45]	[-2.87]
Trade Openness		1.465		1.377		4.436***
		[0.88]		[0.78]		[2.99]
Real Interest Rate, %		-0.105**		-0.129***		-0.074**
		[-2.52]		[-3.61]		[-2.30]
Inflation, %		-0.118***		-0.125***		-0.141***
		[-3.14]		[-3.09]		[-3.93]
Constant	9.627***	8.922	2.454***	3.115*	17.62***	36.25***
	[5.24]	[1.55]	[4.39]	[1.85]	[5.57]	[3.10]
N	1302	786	1302	786	1302	786
R^2 within	0.044	0.116	0.005	0.110	0.052	0.202

t-statistics in brackets. * p<0.1, ** p<0.05, *** p < 0.01. Data source: World Bank.

Strikingly enough estimates in Table 4.8 for the eurozone countries tell a different story, notwithstanding the size of the sample (1999-2007). While we highlight a strong negative and significant conditional correlation between population and GDP growth and a large positive coefficient on trade, turning to our PCA and Jalan's indexes, coefficients are less significant and positive. Nonwithstanding the possible small sample bias, it

seems that European integration through the single market and the monetary union has largely benefited its least populous Member States. The effects of our three size dimensions (population, GDP and arable surface area) thus seem strongly differentiated in the eurozone: that of population considered alone is negative, whereas the effects of the level of national GDP and arable land are positive. Both effects might be specific to the Eurozone and the construction of the European Union (EU). A possible explanation why arable land has been propitious to growth is that some countries like Spain, Ireland and, to a lesser extent, Finland, which have benefited a lot from EU structural funds, have engaged in rapid economic catch-up processes over this period, with considerable territorial effects (shift from agricultural and industrial to new services and real estate activities) and so GDP gains. Another explanation for the positive effect of national GDP refers to the positive externality of being big within the institutional framework of the Eurozone and European Union. Monetary policy, EU policies or the allocation of EU funds are more focused or better designed for important members than small members. For instance, there has been more tolerance for the non-respect of the 3% deficit rule of the SGP for big countries than small ones.

Table 4.8: Country size and GDP growth – Eurozone countries, 1999–2007

Fixed Effects with correction for heteroscedasticity (cluster)						
	bivariate	controls	bivariate	controls	bivariate	controls
PCA Size index	4.931*	14.28***				
	[1.84]	[7.23]				
Jalan's size index			0.132	11.22**		
			[0.06]	[2.59]		
Population, log					-14.67**	-44.53***
					[-2.49]	[-5.41]
Trade Openness		6.493***		7.789***		5.221**
		[5.24]		[3.69]		[2.49]
Real Interest Rate, %		-0.099		-0.032		-0.104
		[-1.04]		[-0.28]		[-1.00]
Inflation, %		-0.270*		-0.132		-0.222
		[-1.75]		[-0.93]		[-1.50]
Constant	0.444	-11.65***	3.031**	-12.11***	32.74**	95.36***
	[0.31]	[-7.66]	[2.42]	[-3.16]	[2.75]	[4.88]
N	134	75	134	75	134	75
R^2 within	0.024	0.328	0.000	0.232	0.063	0.366

t-statistics in brackets. * p<0.1, ** p<0.05, *** p < 0.01. Data source: World Bank.

We have previously mentioned the so-called BRIC (Brazil, Russia, India and China) phenomenon of rapidly-growing, large, emerging economies. Table 4.9 shows that trade (without distinction between manufactured goods or natural resources) is associated with their growth. For these four countries, size is again negatively associated with growth. Besides the economic factors that we control for, these countries also benefit from

an infrastructure boom[9] and a higher attractiveness of foreign investment compared to countries with comparable development level but smaller domestic markets and less political clout.

Table 4.9: Country size and GDP growth – BRICs, 1980–2007

Fixed Effects with correction for heteroscedasticity (cluster)						
	bivariate	controls	bivariate	controls	bivariate	controls
PCA Size index	-6.592	-7.847*				
	[-0.62]	[-5.30]				
Jalan's size index			-0.763	-2.691***		
			[-0.60]	[-32.75]		
Population, log					2.323	-2.193*
					[1.10]	[-4.15]
Trade Openness		12.23**		15.41**		10.05*
		[6.72]		[11.12]		[3.49]
Real Interest Rate, %		-0.112**		-0.106**		-0.128**
		[-6.62]		[-7.17]		[-5.92]
Inflation, %		-0.00822		-0.0138		-0.00511
		[-1.15]		[-2.48]		[-0.51]
Constant	25.95	28.58*	10.2	21.34***	-8.922	18.19*
	[0.77]	[5.58]	[1.22]	[24.96]	[-0.70]	[5.30]
N	102	72	102	72	102	72
R^2 within	0.0238	0.51	0.00555	0.557	0.00445	0.493

t-statistics in brackets. * p<0.1, ** p<0.05, *** p < 0.01. Data source: World Bank.

4.3.3 Discussion

According to our results, the relationship between GDP growth and country size appears negative correlation between size and GDP growth is robust to different measures of country size. Considering all countries, small countries, OECD ones and even BRICs, there is a negative conditional correlation between country size and the pace of growth. Negative effects of size thus seem to outweigh positive ones. The Eurozone displays the opposite outcome and this might be due to its specific institutional framework and peculiar integration mechanisms (as well as a potential small sample bias). Notwithstanding possible misspecification and small size sample issues for certain country groups, how do our results on the non-neutrality of a country size on its growth dynamics dovetail with existing theories (mentioned in Section 2)?

Our results are at odds with both classical and endogenous growth theories. Indeed, the size effects might simply be an artifact of the Solow growth model. Both the PCA and Jalan's indexes contain contemporaneous GDP, and the growth literature (Barro and i Martin (2003)) predicts that conditional GDP per capita growth of countries with

[9] As reported by *The Economist*, investment in infrastructures represented 6% of GDP in the BRICs in 2008, double the figure usually found in developed economies.

higher GDP per capita is lower (the so-called β convergence). Since, the log of GDP per capita equals the log of GDP minus the log of population, this implies that the dependence of GDP per capita growth on log GDP should also be negative *ceteris paribus*. The Solow model also predicts that higher population growth rates lower GDP growth rates per capita, so if larger countries have higher population growth on average in the sample, then the sign of the coefficient on population in a reduced form regression should be negative too. This line of reasoning is based on two assumptions: first, that in our sample country size is positively correlated with population growth rates, and second that country size is positively correlated with GDP per capita. The following two tables report evidence of the opposite and therefore support that the empirical evidence provided in this section is not an artifact of the Solow growth model. Furthermore, a parallel comparison of previous estimates with regressions with GDP per capita growth as a dependent variable shows that country size has a significant negative correlation with GDP per capita growth, though the correlation between country size and population growth is negligible. This suggests that the country size effect previously detailed is indeed on *GDP growth*.

Table 4.10: Correlations between country size and population growth

Variable	PCA size index	Jalan's size index	Population	Population growth
PCA size index	1			
Jalan's size index	0.538	1		
Population	0.959	0.510	1	
Population growth	-0.033	-0.087	-0.047	1

Table 4.11: Correlations between country size and GDP per capita

Variable	PCA size index	Jalan's size index	Population	GDP per capita	GDP per capita growth
PCA size index	1				
Jalan's size index	0.538	1			
Population	0.959	0.510	1		
GDP per capita	0.165	0.239	0.017	1	
GDP per capita growth	0.002	0.048	-0.003	0.054	1

One could also claim we do not put forward a large country advantage for scale-intensive growth because of the lower prevalence of industries with increasing returns to scale documented by Antweiler and Trefler (2002). We could further argue that the costs associated with large size – transport, transaction, heterogeneity – or conversely, the

Table 4.12: Robustness versus Solow model artifact: GDP per capita growth as a dependent variable

Fixed Effects with correction for heteroscedasticity (cluster)			
PCA size index	-0.0386*		
	[-1.75]		
Jalan's size index		0.00339	
		[1.04]	
Population, log			-0.0132*
			[-1.67]
Trade Openness, %	0.0508***	0.0483***	0.0503***
	[3.97]	[3.63]	[4.09]
Real Interest Rate, %	0.000480***	0.000458***	0.000475***
	[3.20]	[3.04]	[3.04]
Inflation, %	-0.000003	-0.000003	-0.000003
	[-1.03]	[-1.08]	[-1.08]
Constant	-0.0149	-0.0218*	0.00276
	[-1.24]	[-1.94]	[0.17]
N	3237	3237	3273
R^2 within	0.0485	0.0445	0.0460

t-statistics in brackets. * p<0.1, ** p<0.05, *** p < 0.01.

benefits of small size –homogeneity, density, higher efficiency and adaptability – prevail in accounting for the effect of country size on GDP growth. The coefficient borne by trade openness is always very positive and all the more for smaller countries. This is in line with theories explaining export-led growth of smaller economies in a free-trade environment,which has been the most successful paradigm for development of emerging economies. Higher growth rates of small countries may be in part explained by their greater openness to trade. Comparing coefficients borne by the PCA size index and by population suggests that population may be more negatively associated with growth than GDP and land area are.

4.4 Country Size and Growth Volatility

4.4.1 Preliminary Analysis

Considering the relationship between country size and output volatility, scatter plots of sample averages excluding outliers[10] in Figures 4.5, 4.6, 4.7 and 4.8 highlight an even stronger negative correlation. This holds for the whole sample (Figure 4.5) and is more acute after 1980 (Figure 4.6), reflecting more turbulent development in the world economy. Small countries (Figure 4.7) and eurozone members (Figure 4.8) illustrate the negative bivariate relationship, in accordance with Furceri and Karras's results.

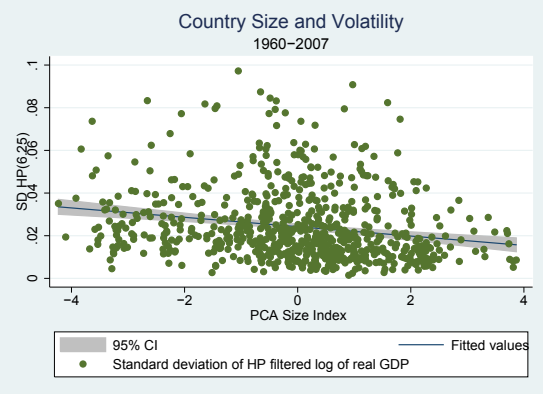


Figure 4.5: Country size and volatility

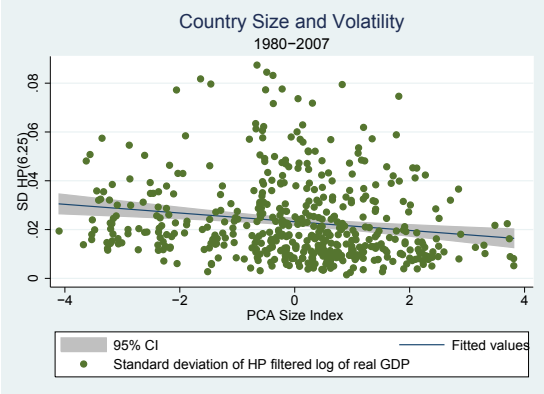


Figure 4.6: Country size and volatility after 1980

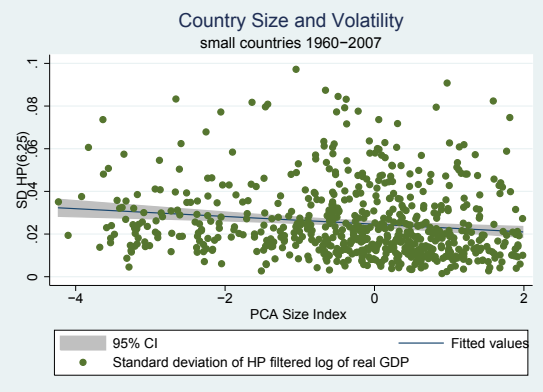


Figure 4.7: Country size and growth in small countries

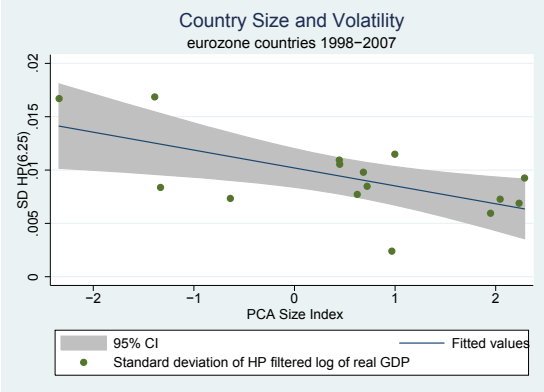


Figure 4.8: Country size and volatility in the eurozone

[10] Observations were excluded when the standard deviation of the HP 6.25 cyclical component exceeded 0.1.

4.4.2 Estimation Results

We now focus on the relationship between our size indexes and growth volatility and still rely on the fixed effects estimation robust to heteroscedasticity (with clustering of errors at the country level). We use the HP filter measures of volatility as our benchmark specification. According to the results reported in Table 4.13, estimated coefficients for the PCA size index and population are negative and significant for all countries, with a tenfold decrease in magnitude in comparison with effects on GDP growth. Small countries are statistically more prone to exhibit volatile growth rates than large ones. Strikingly, the coefficient for trade openness is never significant, contradicting the expectation that it should be correlated with output volatility. Following Easterly, Islam, and Stiglitz (2000), financial exposure and capital movements may be a more important source of macroeconomic volatility.

Table 4.13: Country size and HP volatility – All countries, 1960–2007

Fixed Effects with correction for heteroscedasticity (cluster)						
	bivariate	controls	bivariate	controls	bivariate	controls
PCA Size index	-0.017***	-0.020**				
	[-3.17]	[-2.01]				
Jalan's Size index			-0.005	-0.002		
			[-1.30]	[-1.70]		
Population, log					-0.012***	-0.020***
					[-2.98]	[-3.08]
Trade Openness		0.001		-0.003		0.004
		[0.03]		[-0.27]		[0.34]
Real Interest Rate, %		-0.001		-0.001*		-0.001
		[-1.45]		[-1.67]		[-1.16]
Inflation, %		0.000		0.000		0.000
		[1.54]		[1.38]		[1.42]
Constant	0.026***	0.029***	0.030***	0.031***	0.046***	0.058***
	[154.95]	[3.74]	[11.82]	[4.05]	[7.32]	[6.00]
N	733	447	733	447	743	452
R^2 within	0.024	0.056	0.001	0.046	0.031	0.072

t-statistics in brackets. * p<0.1, ** p<0.05, *** p<0.01. Data source: World Bank.

For small countries, the results in Table 4.14 are very similar to those for the whole sample. Quantitatively, a 1 unit PCA (or 1% population) decrease in size brings on average about 0.02% more growth volatility, confirming the vulnerability to cyclical fluctuations.

In the eurozone (see Table 4.15), country size seems to have a more stabilising effect on output as the negative and significant coefficients generated by the PCA size index and population are about twice as large as those found for the whole sample (between -0.05 versus -0.02 for all countries). Indeed, as the level of trade and investment integration is very high, large countries which experience less volatility may have a greater influence

Table 4.14: Country size and HP volatility – Small countries, 1960–2007

Fixed Effects with correction for heteroscedasticity (cluster)						
	bivariate	controls	bivariate	controls	bivariate	controls
PCA Size index	-0.017***	-0.021**				
	[-3.09]	[-1.96]				
Jalan's Size index			-0.048**	-0.043		
index			[-2.02]	[-1.52]		
Population, log					-0.015***	-0.020
					[-3.92]	[-3.02]
Trade Openness		0.001		-0.001		0.006
		[0.09]		[-0.12]		[0.47]
Real Interest Rate, %		-0.001		-0.001*		-0.001
		[-1.51]		[-1.70]		[-1.22]
Inflation, %		0.000		0.000		0.000
		[1.34]		[1.16]		[1.25]
Constant	0.023***	0.023**	0.040***	0.039***	0.048***	0.052***
	[13.24]	[2.27]	[7.17]	[4.49]	[9.52]	[5.61]
N	662	393	662	393	662	393
R^2 within	0.024	0.059	0.004	0.051	0.042	0.076

t-statistics in brackets. * p<0.1, ** p<0.05, *** p<0.01. Data source: World Bank.

on their counterparts and decrease their volatility. In addition, once again the Eurozone is particular as trade openness is now significant and negative in accounting for output volatility.

In the context of the single market, trade seems to play an anchoring role for business cycles, rather than acting as a source of volatility.[12] We now check the robustness of our

Table 4.15: Country size and HP volatility – Eurozone countries, 1999–2007

Fixed Effects with correction for heteroscedasticity (cluster)						
	bivariate	controls	bivariate	controls	bivariate	controls
PCA Size index	0.03	-0.048***				
	[1.35]	[-2.89]				
Jalan's Size index			0.004	-0.014**		
			[1.52]	[-2.00]		
Population, log					-0.047**	0.034
					[-2.54]	[1.09]
Trade Openness		-0.028***		-0.021**		-0.024**
		[-3.84]		[-2.07]		[-2.08]
Real Interest Rate, %		0.001***		0.001***		0.001***
		[5.28]		[4.90]		[7.03]
Inflation, %		0.001**		0.001**		0.001
		[2.36]		[2.27]		[1.19]
Constant	-0.005	0.065***	0.009***	0.038***	0.105***	-0.043
	[-0.41]	[4.39]	[4.93]	[2.64]	[2.86]	[-0.71]
N	30	26	30	26	30	26
R^2 within	0.069	0.815	0.002	0.746	0.143	0.747

t-statistics in brackets. * p<0.1, ** p<0.05, *** p<0.01. Data source: World Bank.

results obtained with the HP filter by testing the country-size effect on volatility with

[12] For BRICs, we could not find a relationship between size and output volatility.

simple differencing or standard deviation (SD). Using SD detrending, the coefficients are larger, as expected, and confirm a strong negative and significant conditional correlation between country size and business cycle volatility (see Table 4.16). The insignificance of trade in accounting for volatility is confirmed, supporting the assumption that the higher volatility of small countries is driven by other factors.

Table 4.16: Country size and SD volatility – All countries, 1960–2007

Fixed Effects with correction for heteroscedasticity (cluster)						
	bivariate	controls	bivariate	controls	bivariate	controls
PCA Size index	-3.547***	-3.087*				
	[-3.52]	[-1.82]				
Jalan's Size index			-0.715	-0.283*		
			[-1.32]	[-1.75]		
Population, log					-2.383***	-2.634***
					[-3.12]	[-2.62]
Trade Openness		-1.174		-1.660		-0.769
		[-0.87]		[-1.23]		[-0.60]
Real Interest Rate, %		-0.029		-0.04*		-0.019
		[-1.28]		[-1.72]		[-0.82]
Inflation, %		0.002		0.001		0.001
		[1.13]		[0.97]		[1.00]
Constant	4.128***	5.329***	4.713***	5.662***	8.085***	9.334***
	[115.36]	[4.95]	[13.55]	[5.12]	[6.68]	[5.14]
N	729	446	729	446	739	451
R^2 within	0.047	0.052	0.001	0.037	0.056	0.069

t-statistics in brackets. * p<0.1, ** p<0.05, *** p<0.01. Data source: World Bank.

4.4.3 Discussion

Notwithstanding different significance levels according to estimation specifications, we have put forward a negative conditional correlation between country size and business cycle volatility. Other factors implicitly included such as market size (through GDP) or not included in this analysis as the diversification of production or financial linkages may also explain why country size is negatively associated with business cycle volatility. Several theoretical considerations can explain the negative correlation we find between country size and business cycle volatility. Besides the theories mentioned in Section 2, the intuitive notion that larger countries exhibit greater growth rate inertia can be accounted for by Hicks' aggregation theorem: returns to scale in a country's production are a weighted average (according to relative GDP shares) of returns in heterogeneous regional productions. This implies a higher volatility in smaller collection of regions or countries. In contrast, a complementary finding is that trade openness does not appear to be as a source of vulnerability to international economic fluctuations as it is not associated with greater output volatility. Thus, the higher sensitivity to external shocks and greater

volatility of small countries most likely stems from their higher specialisation degree. Indeed, the smallness and insignificance of the coefficients generated by trade indicate that a higher openness to trade does not necessarily mean more vulnerability to external shocks.

4.5 Conclusion

What are the relationships between country size, economic performance and business cycle volatility? To answer this question, we used principal component analysis to develop an original country-size index that includes not only the demographic component of country size as in other papers on the topic but also the GDP and surface area. We thus capture a more complete size effect that goes beyond population.

Using a panel of 163 countries with annual data for the 1969-2007 time span, we put forward, contrary to Rose (2006), a significant negative conditional correlation between country size and GDP growth for all countries. The relationship is even more marked for certain groups such as small countries, OECD and even the BRICs. For eurozone countries, interpreting the relationship proves more complex as the demographic component of country size is negatively correlated with GDP growth but our size index displays a positive and significant coefficient. We suspect peculiar effects of European integration to be at play, which will be the focus of the next chapter.

We confirm the negative conditional correlation between country size and growth volatility described by Furceri and Karras (2007). These results are statistically significant and robust to several specifications of country size and output volatility. The estimations for the PCA size index that we introduced support our assumption that, when accounting for growth and its volatility, there is more to a country than its population figures. Moreover, we corroborate that trade openness is conducive to long-term growth, but find no evidence that it increases growth volatility. These findings implicitly support that industrial specialisation and financial exposure are stronger factors for growth volatility.

Furthering the analysis of country size and economic performance may require looking into less quantifiable factors such as institutions and policies. Rodrik (1998) argues that government plays an income-stabilising role in the face of global uncertainties. This phenomenon, called "exposure mitigation", explains why more open economies tend to have larger governments. Fatas and Mihov (2009) showed that fiscal policy with less discretion reduces volatility and enhances growth. The eurozone, in which we highlighted strong negative relationships between country size, economic performance

and volatility, showcases the peculiar interactions at play with country size in the context of a monetary union.

5 Country Size, Economic Performance and the Political Economy of the Eurozone: an Empirical Study[1]

Abstract

How country size influences economic performance is an area that has received renewed interest lately, especially with Rose (2006), who found no clear pattern between a country's size and its economic performance at the world level. However, when assessing the economic performance of euro-area countries, a "size divide" appears between small, and fast-growing economies and larger laggard ones. I explain this phenomenon by examining how the institutional settings of the eurozone – namely, the Stability and Growth Pact (SGP) and the European Central Bank (ECB) policy – suit the economic structures and policies of the eurozone smaller economies and hinder those of the larger economies. I test these "political economy" hypotheses, using panel data for the fifteen eurozone countries (1998–2008). Robustness checks are run using data for the pre-monetary union period (1960–1998) and for countries that opted out of the monetary union. The econometric analysis confirms that to some extent, the "size divide" in terms of economic performance is a by-product of the monetary union.

Introduction: Stylised Facts on the Eurozone and the "Size Divide"

The topic of how country size influences a country's economic performance has received renewed interest lately, especially with Rose (2006) and before him Armstrong and Read (1998), who found that size (taken as population) did not influence economic performance.

[1] An abridged version of this chapter was published in French under « Taille des pays, performance économique et économie politique de la zone euro » in *Revue de l'OFCE*, N° 112, Janvier 2010.

However, when assessing the economic performance of euro-area[2] countries, a "size divide" appears between small and fast-growing economies and larger laggard ones. This phenomenon motivates this paper and can be illustrated by stylised facts on economic performance and country size in the eurozone. The indicators retained to measure economic performance are: the growth rate, the inflation rate, the unemployment rate, and the external balance. These are also the components of Kaldor (1971)'s magic square and represent four objectives of economic policies not all attainable at once, as there exist a number of trade-offs between them. (The negative one between unemployment and inflation, also captured by the Phillips Curve, being the best known.) Government's general structural balance was also included, as one of the Maastricht criteria focuses on this variable. The timeframe that is covered encompasses 1998–2008 and so starts one year before the launch of the final phase of the monetary union.

As a proxy for country size, I use population (as in Rose (2006) and Alesina, Spolaore, and Wacziarg (2005)). Out of the 15 countries under study, Germany, France and Italy qualify as big; while all others are considered "small" (other rankings and determinants of country size will be discussed in the following section). Figures 5.1–5.6 display inverse relationships between country size (measured by population) and GDP growth, inflation, external balance and general government balances, as well as a positive relationship between country size and unemployment, so that one can talk of a "size divide" in the eurozone on all dimensions of economic performance. More specifically, Figure 2 illustrates the relationship between country size and the differential with average eurozone growth, and so highlights how small countries overperform and larger countries underperform, compared to the eurozone average. To quote Buti and Pench (2004) "a strong negative correlation can be observed between the size of euro-area economies and growth rates".

[2] In this paper, euro area, eurozone and Economic and Monetary Union (EMU) all denote the fifteen countries of the eurozone as of January 1st 2008 (Austria, Belgium, Cyprus, Germany, Greece, Finland, France, Italy, Ireland, Luxembourg, Malta, the Netherlands, Portugal, Slovenia and Spain), and will be used interchangeably. Confusingly enough, all members of the European Union are part of the Economic and Monetary Union, but at different adhesion stages. Therefore, when referring to the EMU, we mean the countries in the final stage (or the euro adoption stage).

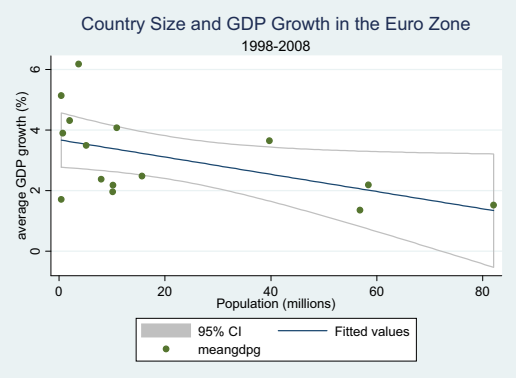


Figure 5.1: Country size and growth

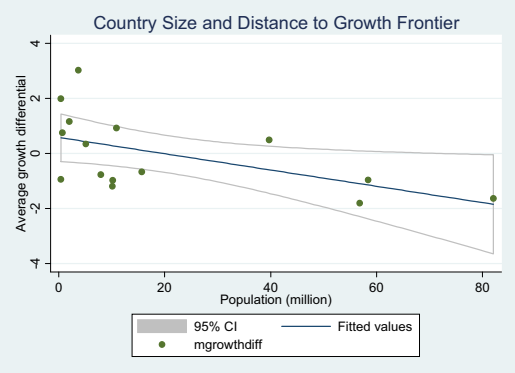


Figure 5.2: Country size and distance to frontier

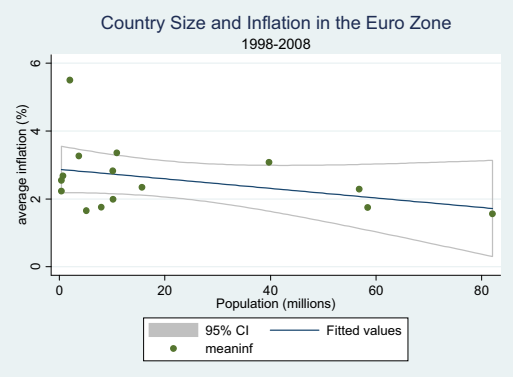


Figure 5.3: Country size and inflation

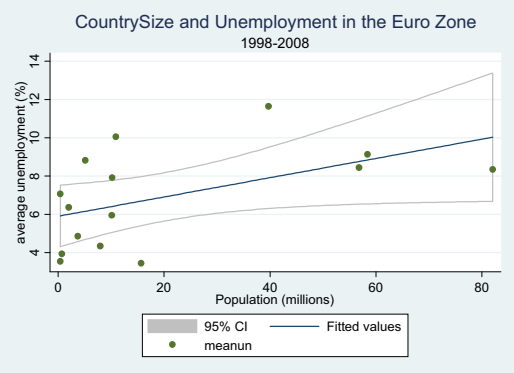


Figure 5.4: Country size and unemployment

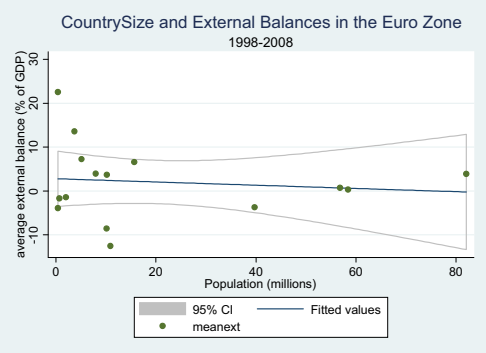


Figure 5.5: Country size and external balance

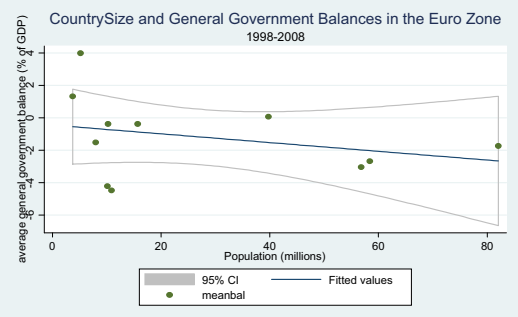


Figure 5.6: Country size and government balance

The aim of this study is not to claim that the relationship between sound economic performance and country size is perfectly inverse. It would be foolish to draw a black and white picture, especially when such complex interactions between politics and economics are at play. Indeed, Figures 5.1–5.6 display various regression fits, and so provide a nuanced snapshot of the "size divide" in the EMU. The within country variance is sometimes larger than that between different countries. Undeniably, each country is a peculiar case per se; however, it is possible to identify groups. Outliers are, in the first place, the new eurozone entrants: Slovenia, Cyprus and Malta. These small countries are still in a phase of catching up and so are bound to differ from their Benelux counterparts, or Ireland. To a lesser extent, Greece and Portugal do not fit the "size divide" picture, as these small countries are still in the process of overcoming the competitiveness drop that the euro parity entailed.

Literature Overview

The literature on the size of countries and its "economic consequences" was launched by Robinson (1960), who pinpointed the vulnerability of small countries but also their greater adaptive capacities. Katzenstein (1985) furthered these findings by characterising the industrialisation and trade integration strategies of small countries that proved especially propitious in Western Europe in a context of trade liberalisation. Rodrik (1998) and Alesina, Spolaore, and Wacziarg (2005) accordingly emphasized the strong inverse correlation between country size and economic openness.

This paper focuses on the economic consequences of different country sizes – or sources of structural heterogeneity – in the framework of the monetary union and so fits into the literature on heterogeneous monetary unions and economic divergence in the European Union (EU). Even before the launch of the monetary union, Armstrong and Read (1995) discussed the better performance of micro states within the EU and attributed it to their economic specialisation in financial services or tourism. Among studies highlighting this "size divide" in the eurozone, that of Laurent and Le Cacheux (2006) underlines a systematic negative correlation between large size and sound economic performance (in regard to growth, inflation, the public deficit and unemployment) between 1996 and 2004 in the eurozone. Napoletano and Gaffard (2009) used parametric estimation to show that large Economic and Monetary Union (EMU) countries have economically fared worse than their smaller counterparts in the decade following the launch of the monetary union and that this was partly due to their heavier reliance on domestic rather than external demand. Similarly, Feldmann (2006) showed that country size in the

EU and unemployment were positively correlated. Saint-Paul (2004) noted that given the incentives structure in the EMU, larger Member States were less likely to reform their labour markets than their smaller counterparts. Buisan and Restoy (2005) detailed how country size and economic divergence were linked in the monetary union. These discrepancies also take root in the settings of the EMU. As documented by the studies by Barbera and Jackson (2006) or Thorhallsson (2006), institutional and economic incentives for small and large countries of the EU and the EMU differ. Using a new economic geography model with economies of scale, Casella (1995) predicted a larger gain from the union's enlargements going to small countries. Buti and Pench (2004), Fitoussi and Le Cacheux (2005) and Chang (2006) all stressed the asymmetry created by the Stability and Growth Pact (SGP) between small and large countries. And finally, the works of Canzoneri, Cumby, and Diba (2005) and Bonnaz (2003) focussed on the impact of the common monetary policy led by the European Central Bank (ECB) on countries of different sizes, with a special focus on inflation differentials.

This paper furthers the analysis of the interactions between country size and economic performance in the eurozone. To this purpose, I describe different specifications for country size and detail the structures and benefits determined within the EU and the EMU (Section 1). I then sketch a brief political economy of size in the eurozone, that is, I examine how country size impacts the conduct of economic policy, focussing on the SGP and the ECB (Section 2). I subsequently test the "size divide" hypothesis by running a thorough econometric analysis using dynamic panel estimation (Section 3) before concluding.

5.1 Country Size in the EMU: Definitions, Structures, Benefits

5.1.1 Country Size: Definitions and Relativity

The EU is composed of countries of very different demographic and economic sizes. Populations vary from 400.000 inhabitants (Malta) to some 82 million (Germany) in 2007, whereas GDP varies from roughly 5000 million (Malta) to 2500 billion euros (Germany). Country size encompasses a large number of dimensions: territory, demography, economic and political power. One of the core difficulties of the analysis is that the relationships between these dimensions are not linear. Large national territories may be sparsely populated and vice versa. Consequently, one may rank countries in almost as many ways as there are indicators. While GDP is a good measure of economic power (and not necessarily of economic development, which is better captured by GDP per capita),

explaining economic performance by resorting to GDP is somewhat tautological and bound to create endogeneity problems. As the relationship between GDP and population – economic and demographic size – is roughly linear, population proves to be a better proxy for country size for this analysis.

A crucial point highlighted by Laurent and Le Cacheux (2006) state that country size and its impact in the eurozone are to be understood in relative terms. Indeed, in absolute terms, Germany, France and Italy are medium-sized countries. Only in the eurozone, or the EU, are they considered "big". Laurent and Le Cacheux (2006) adopted the following size classification: countries with a population of up to a quarter of the most populated Member State falls into the small category, countries up to a half into the medium and countries over half into the large category. By this token, the eurozone has three large countries – Germany, France and Italy, making up for 70% of the eurozone's GDP – , one medium country – Spain – , and 11 small countries. The recent adhesion of Cyprus and Malta also prompts the question of whether an additional "extra small" category should be added. However, in terms of population, Luxembourg would fall into that "extra small" category, despite a large economic size. For the purpose of clarity, I will only consider these three different sized groups as specified by the Laurent and Le Cacheux (2006) study.

5.1.2 Country Size and Economic Structures

Following Salmond (2006), one can define large countries as countries accounting for a large part of the EMU economic activity, tending to act as *price makers* in this market. Conversely, small countries represent a low proportion of the EMU economy and behave as *price takers*. By and large, small countries tend to be more *open to trade* (Rodrik (1998) and Alesina, Spolaore, and Wacziarg (2005)), while large ones rely more on the *internal demand* for growth. It follows that small countries are more vulnerable to external developments and more prone to lead competitiveness strategies in order to expand exports. In larger countries, policy makers must address internal stabilisation. Figures 5.7 and 5.2 illustrate the structural differences between the small and large countries of the eurozone in terms of openness (the ratio of the sum of exports and imports to GDP) and domestic demand (as a percentage of GDP) as components of the economy. Small countries display indeed higher openness ratios and more often than not, domestic demand represents a higher share of GDP in large countries. The inverse relationship is however much more evident for trade openness than it is for domestic demand. This is one of the core structural differences between the two groups, but this is a somewhat blunt picture: on the international

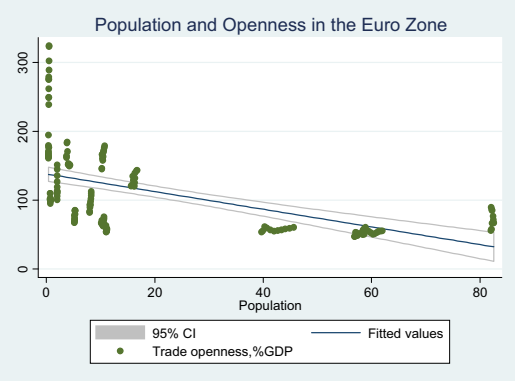


Figure 5.7: Country size and openness

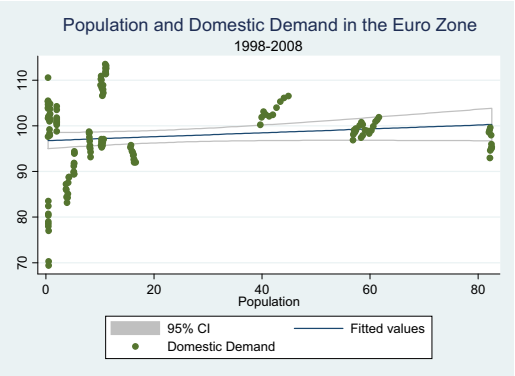


Figure 5.8: Country size and domestic demand

level, large eurozone economies are only mid-sized economies coping simultaneously with what I defined as small and large country challenges. They can neither neglect their competitiveness, nor care only about competitiveness and sacrifice internal stabilisation. In addition, to detail the argument developed by Alesina, Spolaore, and Wacziarg (2005), if small countries are more open to trade, it is because they benefit more, in relative terms, from the openness than do large countries under a liberalised trade regime; as also noted earlier by Lloyd (1968), p. 4: "small nations obtain greater gains per unit of international trade than do large nations". Not only do small and large countries differ in their degree of openness, their trade specialisations mirror their different economic structures. Small countries may not be able to ensure the viability of industries with large scale effects as noted by Martins M.G.P (2004), and Torstensson (1997) found empirical evidence for this comparative advantage pattern in trade flows with large domestic market countries being net exporters in scale intensive industries.

These disparities between small and large countries translate into *different exposure to shocks and policy transmission mechanisms*, and so account for diverging economic performance as illustrated by Buisan and Restoy (2005). The origin of shocks may induce a "size-conditioned" reaction. For instance, the sensitivity to external demand shocks depends on openness, which is strongly and negatively correlated to size. In the eurozone, the less open countries include France, Italy, Portugal and Greece, while the more open are Belgium, Finland, Ireland and the Netherlands. Likewise, oil price shocks affect the three big countries according to similar dependency ratios, ratios that are higher in small countries like Greece, Portugal, Belgium and Spain. Export specialisation is also an important source of heterogeneity in reactions to external shocks, but identifying a

size pattern here proves difficult. Germany, for instance, has an export specialisation that differs significantly from those of its French or Italian counterparts.

5.1.3 Vulnerability and Efficiency

The small countries' greater vulnerability to international conditions may actually be a blessing in disguise. The smallness of their own domestic market does not permit them to decrease their export share, and so they are bound to produce and implement economic change in a more efficient manner. One has also argued that smaller countries, having a more homogeneous population and smaller territories to control, have better institutions and are more prone to reach a political consensus, as documented in Robinson (1960). Following more recent work by Persson (2002),countries where parliamentary coalitions prevail [3] are also countries where a higher legislative cohesion and efficiency is observed. The problematic of country size thus urges us to include consider national efficiency. To this end, I have computed measures of output or productivity per square kilometer. This provides a picture of what I refer to as *"territorial efficiency"*. The importance of territory effects has indeed been highlighted by the new economic geography approach (Krugman (1991)). While it posits the importance of increasing returns to scale, and thus, a priori bestows an advantage to large countries, it also takes into account the location, structure and density of economic activity (usually higher in smaller countries). As stated earlier, country size encompasses several dimensions and however convenient it may be to limit country size to population, a population alone does not make an economy. Key economy ingredients also include material resources and a territory. Hence, the need to sophisticate my analysis by adding two additional size rationales – GDP and surface area – as the ratio of economic size over geographic size. With this *"territorial efficiency"* measure, I intend to depart from a mono-variable representation of country size and include physical aspects in my analysis. Again, because countries are differently ranked along the population, GDP and territory dimensions, this measure does not provide as straightforward a "size ranking" (as population or GDP for instance do), and so should not be understood as such. Instead, it is meant to capture country structural differences in terms of the economic organisation over a given territory. Figures 5.9 and 5.10 offer a snapshot of "territorial efficiency". According to the indicators chosen (productivity or output per 1000 km^2, for an alternative measure see Figure C-1 in the Appendix), rankings between countries differ. However, one may note the relative territorial inefficiency of

[3] Austria, Belgium, Finland, Germany,Ireland,Italy, Luxembourg, the Netherlands, so both large and small countries in the monetary union

small southern and new Member States, the medium territorial efficiency of the big three countries, and the higher efficiency of the Netherlands and Luxembourg.

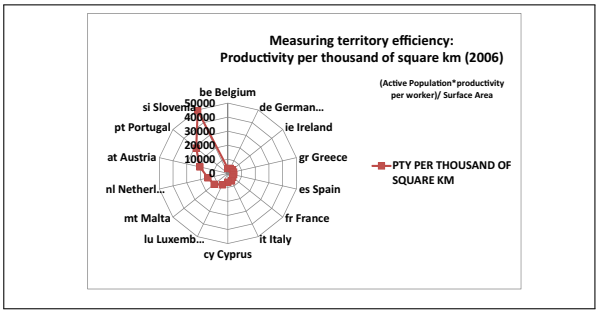


Figure 5.9: Territorial efficiency relative to productivity

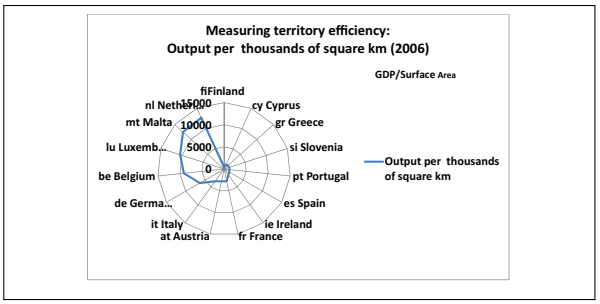


Figure 5.10: Territorial efficiency relative to output

For this analysis, I retained a rather simple ratio of GDP over land area (output per 1000 km^2) as the measure for territorial efficiency.[4] This measure is far from perfect, and one should be aware that it can be driven up or down by a relatively small, or respectively large, territory (as compared to the size of the economy), as the polar cases of Malta and France illustrate. But it offers a relevant picture of the density of economic activity, and of where there is still room and potential for improvement.

Figure 5.11 displays national GDP growth rates and territorial efficiency ratios. Three groups may be distinguished. First, those with high territorial efficiency consist of the Benelux countries and Malta. The Benelux countries are indeed located at the very heart of the Blue Banana (or the European economic core that spans from Southern England to Northern Italy via the Rhine region) and are typically very open and efficient small economies. It goes without saying that their smallness does not leave much room for territorially extensive growth. At the other end of the spectrum, the least territorially

[4]Gallup, Sachs, and Mellinger (1999) developed a similar indicator coined "GDP density", calculated by multiplying GDP per capita by the number of people per square kilometer.

efficient group is primarily made up of countries that are either new and less developed entrants (Cyprus and Slovenia) or still catching up in terms of economic structures (Greece, Portugal, and Spain). Germany performs well in terms of territorial efficiency, but is certainly advantaged by its relatively small territory (the fourth in the EU).

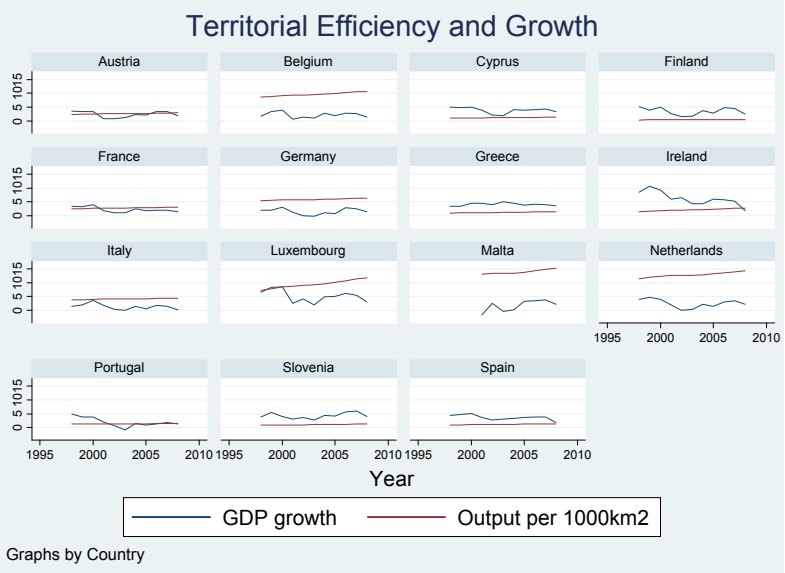


Figure 5.11: Territorial efficiency and GDP growth

The middle group is comprised of Austria, France, Ireland and Italy. France and Italy, the two large countries in this group have different territorial structures. France still furthers devolution policies to overcome Paris' macrocephaly, while Italy displays a denser network of industrial centres and is struggling with obsolete industrial structures (especially in the South). Ireland and Austria are two small countries with intermediate territorial efficiency: Austria lies at the heart of continental Europe and has based a development strategy that fully takes advantage of its geographical situation, as it became a hub for exchanges and investment with the new Eastern European Members. Ireland internalised its insularity, as it overcame its relative remoteness and isolation by leading attractive fiscal policies for multinationals and outsourcing service centres. There remain two peculiar outliers, however, Malta is pushed up by its very small territory, and conversely, Finland pulled down by its large one, so that one cannot correctly assess their respective territorial efficiency with this GDP to territory ratio.

As for how territorial efficiency is related to GDP growth, Figure5.11 reflects the topic's complexity as a number of variables interacting at the national and eurozone levels explain national discrepancies in economic performance. However, if a country

experiences a protracted period of GDP growth, the ratio of GDP to surface area will rise over time. Because GDP is not a cyclical indicator but an economic aggregate with inertia, the ratio of GDP to surface area offers a more structural or long term oriented picture of a country's economic evolution. Strikingly enough, over the decade covered (1998–2008), a majority of countries stagnate in terms of territorial efficiency and only small economies (the Benelux countries, Ireland and Malta) see it increase, with the notable exception of Germany (that phenomenon being possibly explained by the catching up of the new Bundesländer).

To better fathom the interactions at play between territorial efficiency and the repartition of economic activity, I have computed correlations with population density and the percentage of the population living in the largest city (a proxy for centralisation of economic activity) in Table 5.1.

Table 5.1: Correlation structure of territorial variables

Variables	GDP growth	Output per 1000 km^2	Population density	Population in largest city, %
GDP growth	1			
Output per 1000 km^2	−0.2094	1		
Population density	−0.1934	0.9192	1	
Population in largest city, %	−0.1701	−0.1508	−0.2127	1

Thus it appears that density is highly correlated with territorial efficiency (+0.9192), confirming the assumption that small denser countries make efficient use of their territory, whereas the opposite goes for centralisation, though the negative correlation is not as high (−0.1508). In addition, the fact that the relationship between territorial efficiency and country size (taken as population) is neither evidently positive nor negative is an asset for my analysis (see Figure C-2 in the Appendix), as it will prevent the occurrence of simplistic or caricatured results in regard to the economic effects of country size.

Now that we have seen how country size impacts on national economic structures, it is time to focus on the institutions of the EU and the EMU and how they favour small countries.

5.2 A Political Economy of Size in the Eurozone

The EU, or for that matter, the EMU, cannot be considered as a solely economic organisation. Their political essence makes the sheer economic analysis of their functioning obtuse. The creation of the monetary union was mostly motivated by political reasons, not by

optimality in the economic theory sense. As European policies are based on the premise of institutional equality between sovereign states and economic convergence, they are often so called "one-size-fits-all" policies. This non-acknowledgement of size within the EU and EMU mars economic outcomes, hence the need to sketch a political economy of size in the eurozone. In other words, examine how country size as a non-internalised source of heterogeneity predetermines the way national economies will fare within the EMU. To this end, I first focus on the general institutional frameworks of the EU, before dealing with the economic policy settings of EMU.

5.2.1 The EU and EMU Frameworks Bestow Small Countries with Institutional Advantages, . . .

Because of their greater vulnerability to external developments, the institutions of the EU and the fear they be smothered by larger countries, smaller countries were granted a number of advantages and protections upon joining the EU. Interestingly enough, at its creation, the European Coal and Steel Community (ECSC) included the"three big" and three small countries, a configuration in which smaller countries obviously needed extra guarantees and protections against the power of the three big. These original six countries have mechanically had more opportunities to influence the institutional system in their favour; and while there was only one large European country left (the United Kingdom (UK)) to join the EU, there were still plenty of small ones. The *institutional protections* (Thorhallsson (2006)) bestowed to small countries are unanimity ruling; the generalised search for consensus, even if it is not legally necessary; overrepresentation in voting rights granted relative to population figures; the possibility to form blocking minorities (and with each enlargement automatically increasing the number of possible coalitions, and so augmenting the likelihood that small countries have an impact on collective decisions); the Commission's logistical help and the recognition of special interests (e.g., Luxembourg in banking and Cyprus in shipping). Consequently, in terms of political and decision-making power, EU membership enables these small states to punch above their weight. Following Keohane (1969), a small state is by definition no great political power in the sense that "[its] leaders consider that it can never, acting alone or in a small group, make a significant impact on the system". To some extent the EU and later the EMU changed this hard fact of international relations. Rose (2006) highlighted the new *sovereignty scale* for small countries within the EU. The *overrepresentation* of small states detailed by Barbera and Jackson (2006), and conversely, the "shrinkage" of large ones, can be precisely assessed. The ratios of GDP and population between Germany and Malta are

roughly 1 : 400 and 1 : 160, whereas the ratios of their numbers of European Parliament representatives and voting rights in the Council of Ministers are 1 : 20 and 1 : 10! Creel, Laurent, and Cacheux (2007) also showed that 70% of the economic size of the EU was represented by 40% of its political size, this discrepancy holding paradoxically for the EMU, where political cooperation is sizeably deeper.

5.2.2 ... Which Turn into Economic Gains

Casella (1995) asks the question of whether "there are systematic forces such that countries of different sizes participating in a free trade bloc gain differently from the entry of new members". Assuming increasing economies of scale, she showed that small countries, whose internal market and competitiveness increases with enlargement, benefit more from enlargement, as opposed to large countries whose domestic markets proportionally shrink with each enlargement. In fact, the increase in the internal market is more significant for firms in small countries than for firms in large countries, and the same goes for competitiveness. The EU, as it plays down the importance of the size of the domestic market in offering its members access to a very large *single market*, clearly favours the development of small countries (for which domestic market size was the weakness to overcome) over that of larger ones (for which domestic market size used to be one of the main assets). Furthering Casella's analysis, Badinger and Breuss (2006), argued that this *small country bonus* is not significantly larger than the advantages large countries have in terms of high-market power, trade, market size, group ties, endowments in human capital and technologies, product varieties, and scale economies. Thus, different economic forces are at play in the distribution of the gains of trade bloc enlargement without one dominating the others, leaving the outcome in terms of country size undetermined. Furceri and Karras (2008a) also underlined that small size was positively correlated with *business cycle volatility*, which explains part of the small Member States' vulnerability, but also their larger gains from the EMU, as business cycles are anchored in the monetary union.

All in all, small protected states gain economic and political power in entering the EU and the EMU, while the contrary is true for large states. For instance, before adopting the euro, no small country had a currency that they could use as a "monetary weapon". Conversely, Germany gave up a lot with the deutschemark: not only an international currency, but also the ability for the German government to borrow at lower rates than its European peers. With the euro, Germany lost this exclusive *comparative* advantage, while small countries gained lower interest rates, greater credibility on financial markets and the

shelter of an international currency. As Robinson (1960) remarked, in terms of the public good provision (for instance defense), large countries hold a comparative advantage but only as long as they do not share it. In short, one may contend that in joining the EMU, larger countries, such as Germany, traded monetary weapons (the deutschemark against the euro) and economic advantages (undisputed monetary leadership against reinforced economic stability outside German borders) while small countries made net gains in terms of economic power and protection.

5.2.3 Country Size and the Economic Government of the Eurozone

Now that we have seen the adverse effects of the EMU institutional setting on the policies of large countries, let us now carry a more thorough analysis, with regards to the two main devices of economic policy in the eurozone, namely, the SGP, and the ECB.

The SGP and the global demand externality

The SGP was designed with the launch of the monetary union on the tenet that *fiscal externalities* had to be contained, so as not to jeopardise the conduct of a common monetary policy (through a raise in the common interest rate caused by inflated national debt ratios or default). The retained criteria included the threshold limits of respectively 3% and 60% of GDP for the public deficit and the public debt, respectively, as it fitted the figures of the time. The SGP has received numerous criticisms and was reformed in March 2005 to better take into account the cyclical position and national peculiarities when assessing the deficit, but its essence did not change. Obviously the containment logic behind the pact addresses the fiscal externalities *large* countries may impose on others as a consequence of their fiscal policy: a public debt default of Italy would put the monetary stability of the zone in much greater jeopardy than one in Greece or Ireland.

What about the ease of abiding by these fiscal limits? According to Persson (2002), the proportional parliamentary systems found in most eurozone countries are empirically proven to induce excessive public spending by governments seeking reelection. However, since larger and less open countries tend to have a greater *fiscal multiplier* – that is a higher return of government expenditures and tax cuts in terms of growth – ‚abiding by the SGP's fiscal limits represents a greater loss in terms of efficient policy instruments them. The benefits that larger countries may reap from enhanced fiscal credibility are also relatively smaller, because their position on financial markets and notation agencies grades are less sensitive to the evolution of their debt and deficits ratios. We have seen

that smaller countries have rose up in arms against the alleged fiscal laxness of their larger counterparts. However fiscal consolidation is not necessarily easier for smaller countries. It is easier for countries enjoying high growth rates (most often small ones, as illustrated previously), as the play of automatic stabilisers alleviates the fiscal effort. As noted by Bonnaz (2003), the relative easiness of fiscal consolidation only applies to very open small economies, such as Ireland, Portugal, Belgium and the Netherlands, since their public finances Keynesian multiplier is lower. But small countries, such as Greece, Finland or Spain, experience conditions similar to those of France and Germany.

The fiscal containment logic behind the SGP holds water but it does not take into account all relevant externalities in a monetary union. Bonnaz (2003) emphasized the need to consider "*global demand*". Indeed, through their higher inflation, small countries are responsible for more negative externalities as their larger counterparts through their "lax" fiscal stance. Small countries benefit from an asymmetry in real interest rates within the monetary union. They also generate a sizeable inflation externality[5] (Spain and Ireland are among the countries with higher inflation rates), which is not internalised by way of sanctions and is a real burden for the larger countries of the eurozone, as they have to put up with less favourable real interest rates.

The ECB and country size

The ECB is no exception to the overrepresentation of small countries that characterises European institutions. The mismatch between the political and economic weights of regional governors in the ECB's decision instances is obvious because of the "one country, one vote principle". This has led to larger degrees of *misrepresentation*, than in the Federal Reserve and the Bundesbank (Berger (2006)). The enlargement of the EMU will further this trend. The 2003 reform established the vote limitation to 15 national central bankers and 6 board members and will only limit this effect but not reverse it. Rotation will also help check misrepresentation, but will cause discontinuities in voting frequencies between large and small countries. Even if the earlier economic definition of small countries as price takers, respectively large as price makers may hold here: developments in large countries are closely monitored by the ECB, while those in small countries are unlikely to change its policy stance (Canzoneri, Cumby, and Diba (2005)). The underlying

[5] Bonnaz (2003) calculated that between 1999 and 2002, small countries generated, on average, 1% more inflation than the big three, which, given their weight in the eurozone, translated into an additional 0.3% to the inflation of the zone. Following a Taylor rule, and all other things being equal, the author computed that this pushed interest rates 50 base points over their original level, had the small countries had similar inflation rates as the large ones.

tenet that a national representative will systematically push its own country's interest (as is assumed in Dixit and Lambertini (2003)) is debatable. As a consequence, the representation and governing system of the ECB does not tell us much about the impact of the central bank's policies on countries of different sizes, as the decisions processes are not public and one can only speculate about what goes on behind closed doors.

To analyse how country size and the policy led by the ECB interact, one should consider the impact of country size in the classical output/inflation trade-off, or the *Phillips Curve*. That trade-off is affected by openness and so by country size (as the three big economies are relatively more closed and a number of small economies, including Benelux, are significantly more open). Sanchez (2006) documented that small countries, because of their greater openness and larger inflation effects, have a steeper supply curve, and conversely, larger countries have a flatter supply curve. Because of this, monetary union is more propitious to small countries with steep supply curves, while for larger countries, monetary autonomy outperforms monetary union. The outcome in terms of welfare costs for small and large countries is however disputed. Indeed, Canzoneri, Cumby, and Diba (2005) reach the opposite conclusion: using a two-country partial-equilibrium model calibrated to the EMU, they find that because the ECB pays less heed the inflation in small countries, the latter bear four times higher welfare costs in terms of price and wage rigidities than their larger neighbours.

5.3 Econometric Analysis

Let us now see whether the incidence of country size on the workings of the eurozone can be empirically confirmed.

5.3.1 Model

I examined the correlation between country size (using population as a proxy) and GDP growth for the 15 countries of the eurozone, controlling for economic variables that are size-dependent (trade openness, domestic demand, and territorial efficiency), eurozone economic government variables (inflation and deficit differentials), and a time-invariant omitted bias effect (fixed effect). I estimate the following equation:

$$\begin{aligned} GDPgrowth_{it} = &\beta_0 + \beta_1\, Population_{it} + \beta_2\, TradeOpenness_{it}/DomesticDemand_{it} + \\ &\beta_3\, Output\ per\ 1000\ km^2{}_{it} + \beta_4\, \Delta Inflation_{it} + \beta_5\, \Delta Deficit_{it} + u_i + \delta_t + \epsilon_{it}. \end{aligned}$$

And additionally, in a dynamic panel setting, I further estimate the following equation:

$$GDPgrowth_{it} = \beta_0 + \beta_1\, GDPgrowth_{it-1} + \beta_2\, Population_{it} + \beta_3\, TradeOpenness_{it} / DomesticDemand_{it} + \beta_4\, Output\ per\ 1000\ km^2{}_{it} + \beta_5\, \Delta Inflation_{it} + \beta_6\, \Delta Deficit_{it} + u_i + \delta_t + \epsilon_{it}.$$

Where: i indicates the countries (panel variable), t is time, u_i, $\delta_t$and ϵ_{it} respectively denote country effects, time dummies and the error term. *Population* is the population in millions of inhabitants for a given country in a given year. *TradeOpenness* is the ratio of the sum of exports and imports over GDP. Alternatively, for large countries, I control for *DomesticDemand* as a percentage of GDP. Trade openness and domestic demand, as I explained earlier, are the economic engine of small respectively, large economies. *Output per 1000 km*^{2} is the ratio of GDP (in billions of euros) over surface area (in thousands of square kilometers) and is my measure of territorial efficiency. Δ*Inflation* and Δ*Deficit* (both in percentages of GDP) are the two measures of inflation and deficit in relation to the policy of the ECB and the Maastricht criterion that I used to assess the impact of the eurozone "economic government".

5.3.2 The Data, the Variables and their Correlation Structure

Two data sets are used. The first covers the 1998–2008 period for the fifteen countries of the eurozone (though the three latest entrants Malta, Cyprus and Slovenia did not necessarily fit the "size divide" as I previously explained) and comes from Eurostat. The second dataset covers the 1960–2007 time span and comes from the World Bank. As it includes the pre-monetary union period and Member States that opted out of the EMU, the regressions ran will be akin to robustness checks or "placebo" tests. Both data sets were normalised with the same units and provided consistent estimates when regressions were run with data for the same countries and years. Some data, especially for the domestic demand and deficit gap variables, is missing, hence, the fluctuating number of observations. (See Table C-1 in the Appendix for descriptive statistics of both data sets.)

To measure economic performance, I focussed on GDP growth. One could argue that the GDP indicator is only quantitative and does not necessarily capture the quality and repartition of growth (possibly better captured by GDP per capita or less quantitative indicators such as the Human Development Index for instance); however, my purpose is to assess the impact of the EMU on national economic performance in quantitative terms and so I will use GDP growth as the dependent variable. In the following correlation

structure analysis (see Table 5.2), I also include unemployment, the external balance as a percentage of GDP (Bal_pro) and inflation (i.e., the three other components of Kaldor's magic square) so as to provide a more complete picture of economic performance. Using the 1998–2008 data set, I find negative correlations between the indicators of country size (population and GDP) and all economic performance indicators (GDP growth and unemployment being respectively negatively and positively correlated with population).

Country size is as previously noted, measured by population or GDP. To test for a quadratic relationship between country size and economic performance, population squared is added to the correlation analysis, but as shown in Table 5.2, it does prove very conclusive. The correlation between domestic demand (taken as a percentage of GDP) – supposedly, the economic engine of large economies – and economic performance was negative. Figures 5.12 and 5.13 cast some light on the fact that openness seems to be a better economic engine for growth than domestic demand in the EMU, thus, partly explaining the discrepancies in terms of economic performance along the "size divide" (as noted by Napoletano and Gaffard (2009)). Domestic demand and trade openness are complementary economic aggregates and, to some extent, superposed (imports are also a part of domestic demand which is also defined as GDP minus net exports). To avoid misspecification, I used them as alternative controls (i.e., the performance of large countries was regressed on the domestic demand and that of the smaller countries was regressed on trade openness). But as seen previously, the three large eurozone economies are in fact mid-sized economies on an international scale, which may also heavily rely on exports (especially Germany).

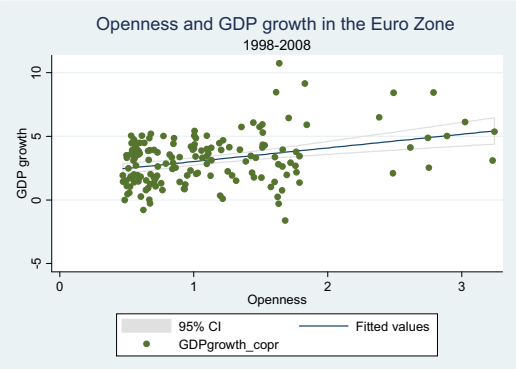


Figure 5.12: Openness and GDP growth

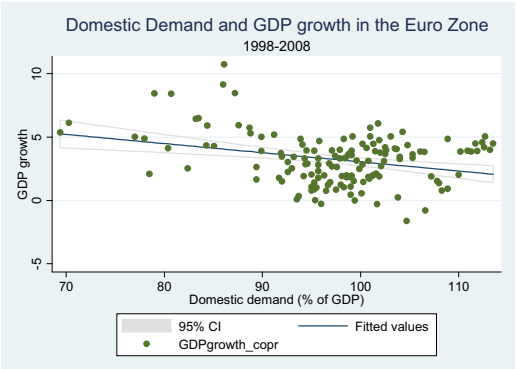


Figure 5.13: Domestic demand and GDP growth

The openness and the inflation gap (ΔInflation=Inflation rate-2, measures whether the country's inflation is above or under the 2% threshold that the ECB used to define price stability and captured the real interest rate differential across countries) are positively correlated with growth and negatively with size, which confirms the small countries' advantages in the eurozone. The deficit gap (ΔDeficit=Budget deficit+3, is negative for countries running deficits larger than the 3% limit and positive for those within the Maastricht bounds) is positively correlated with growth but very strongly and negatively correlated to domestic demand. This hints at a possible growth impediment for countries relying heavily on domestic demand and running large deficits, i.e., large countries. These inflation and deficit differentials are meant to reflect the institutional settings of the eurozone and how far the economies fell away from the macroeconomic stability targets, or bounds of the ECB and the SGP. These targets often bear opposite signs, according to whether a country is big or small (especially Δ*Inflation*, because of the higher inflation on average in small countries over the sample). The correlation structure of my indicator for the territorial efficiency indicator, or output per 1000 km^2, was not straightforward in regards to country size but, in accordance with the non-linearity of their relationship (see Section 1), it is because the relationship between both variables is not linear.

Table 5.2: Correlation structure of variables

Variable	GDP	GDP growth	Unem-ployment	Popu-lation	Trade Openness	Domestic Demand	Output per 1000 km^2	ΔInflation	Δ Deficit
GDP	1								
GDP growth	-0.4008	1							
Unemployment	0.2759	0.0001	1						
Population	0.9732	-0.3881	0.3945	1					
Trade Openness	-0.4147	0.3261	-0.5177	-0.5278	1				
Domestic Demand	-0.0033	-0.2067	0.3036	0.1183	-0.6188	1			
Output per 1000 km^2	0.1482	-0.2896	-0.3676	0.0589	0.5305	-0.282	1		
Δ Inflation	-0.3081	0.2512	-0.1009	-0.2379	0.1095	0.2073	-0.1657	1	
Δ Deficit	-0.2277	0.3839	-0.084	-0.2694	0.4267	-0.6912	0.025	-0.1317	1

Summing up the various arguments made as to which economic and institutional factors country size impacts upon (positively or negatively), the model I empirically estimate takes the following form for large countries:

$$GDPgrowth = f(\underset{-}{Population},\ \underset{-}{DomesticDemand}, \underset{?}{Output\ per\ 1000\ km^2}, \underset{?}{\Delta\ Inflation}, \underset{+}{\Delta\ Deficit})$$

Conversely, for small countries, I expect the underlying model to be as such:

$$GDPgrowth = f(\underset{-}{Population}, \underset{+}{TradeOpenness}, \underset{?}{Output\ per\ 1000\ km^2}, \Delta \underset{+}{Inflation}, \Delta \underset{?}{Deficit})$$

Where: *Output per 1000 km*^{2} for territorial efficiency, Δ*Inflation*, for the inflation differential, and Δ*Deficit*for the deficit differential.

5.3.3 Estimation Strategy

To estimate my model (see equations at the beginning of this section), I heeded the issues raised by Baltagi (2005), i.e., the relationship between the country (or fixed) effects and the regressors. My non-dynamic panel data analysis relies on the Generalised Least Squares (GLS) model to obtain the best linear unbiased estimator. I chose the fixed effects (FE or within) over the random effects (RE or between) estimator given the results of the Hausman test. It indicated that the individual effects and our explanatory variables were systematically related, so that the fixed effects or within estimator was appropriate.[6] The choice of a fixed-effects estimation was further justified by the small number of countries, the high correlation values of the individual intercept term u_i, the constant term and an F-test for the significance fixed effects. The Wald test for group-wise heteroscedasticity confirmed its presence in both data sets. Likewise, the Wooldridge test for autocorrelation in panel data indicated a first-order correlation. Following Drazen (2000), country size was not assumed to be an important source of endogeneity and so the IV estimator was not employed.

Taking these results into account, I selected three estimators for the non-dynamic estimation: (1) GLS with a specification robust to panel-level heteroscedasticity and first-order autocorrelation, serving as a rationale to assess the impact of the FE estimator; (2) FE using a specification with robust standard errors clustered at the country level (as clustering at the panel data level produces consistent estimates of standard errors even in the presence of autocorrelation); and (3) FE robust to first-order autocorrelation. In the case of the dynamic estimation (see model estimated below), the presence of the lagged endogenous variable – justified by the presence of autocorrelation – was crucial in selecting an appropriate estimator, as the FE is inconsistent in the presence of a lagged variable (Baltagi, 2005; Kiviet, 1995). Panels were checked for unit roots using

[6] The tests yielded $\chi^2(5) = 29.44$ and $p < \chi^2 = 0.0$ in the 1998–2008 data set, and $\chi^2(5) = 175.27$ and $p < \chi^2 = 0.0$ in the 1960–2007 data set.

a Fisher test (or augmented Dickey–Fuller test with one lag), which dismissed their presence, so that co-integration is not necessary. I estimate the dynamic model using (4) the Arellano–Bond (AB) estimator with a robust variance specification and allowing for serial autocorrelation. The AB estimator controls for unobserved time-invariant characteristics of countries and captures the impact of the changes in the variables across time. To ensure the consistency of this generalised method of moments (GMM) estimator, I tested whether average autocorrelation in the first and second order residuals was equal to zero. It was particularly important that the second order autocorrelation condition was fulfilled, which is the case in all the estimations (results reported in the regression Tables 5.3, 5.4 and 5.5).

Table 5.3 presents the results[7] of the four estimations for the 1998 to 2008 period, for all fifteen countries in the eurozone.

Testing the relationship between growth and country size (taken as population), the FE estimator with robust variance confirms a significant inverse relationship.[8] Using the summary statistics (Table C-1 in the Appendix), we find that according to the FE cluster estimator, a one-standard-deviation increase in population lowers the growth rate on impact by 4.5[9] standard deviations. Trade openness exhibits a positive significant relationship with growth and likewise the size of the effect on growth is substantial (a positive variation of one standard deviation of trade openness yields an increase in growth of 2.52 standard deviations according to the FE cluster estimator). The FE estimators were more conclusive than the GLS estimators as coefficients are larger in absolute value and more significant (for the FE estimations all coefficients are except that borne by the deficit gap).

5.3.4 Assessing the "Size Divide"

To test the "size divide" hypothesis, I run the same regression as before, but separately for large and small countries (note that Spain was dropped of the regressions as it was the only mid-sized country falling in neither categories). Table 5.4 details the results for the large countries. The country size coefficient gained size and significance, confirming the hypothesis of an inverse relationship between economic performance and country

[7] The inclusion of time effects, so as to possibly capture the effects of a "eurozone business cycle" proved conclusive only in the case of small countries and is displayed in Table C-2 in the Appendix. In fact, time effects were proven to be overall significant, but not individually (using a usual F-test). Given the limited number of observations and degrees of freedom, we considered the results less relevant and favoured estimations including only individual effects.

[8] Taking the logarithm of population (instead of population in millions) yields similar results.

[9] Computed as such: β Population* σ Population/ σ GDP Growth or $-0,342 * 25,6/1,93 = -4,5$

Table 5.3: Regressions of GDP growth in the eurozone countries, 1998–2008

Estimation method (error specification)	**GLS (hetero AR)**	**Fixed Effects (cluster)**	**Fixed Effects (AR)**	**Arellano–Bond (AR)**
Population	-0.0203*	-0.342*	-0.421	-1.964
	(-2.12)	(-3.01)	(-1.81)	(-1.62)
Trade Openness	1.056	7.980***	8.728***	12.16**
	(1)	(8.79)	(3.82)	(2.65)
Output per 1000 km^2	-0.238*	-1.431**	-1.384*	0.215
	(-2.55)	(-4.46)	(-2.36)	(0.19)
Inflation gap	-0.134	-0.542***	-0.425*	-1.089***
	(-0.96)	(-7.42)	(-2.49)	(-4.82)
Deficit gap	0.0212	0.198	0.195	0.433
	(0.31)	(1.34)	(1.77)	(1.88)
Lagged GDP growth				0.0348
				(0.28)
Constant	3.626***	10.96**	12.20**	45.78
	(4.54)	(3.57)	(3.05)	(1.55)
N	119	119	108	109
Wald test for groupwise heteroscedasticity H_0: σ_i=σ for all i $\chi^2(11) = 89.25$, p=0.00	R^2 within	0.365	0.252	H_0: no 1st-order autocorrelation, $p = 0.01$
	σ_u	11.42	13.68	H_0: no 2nd-order autocorrelation, $p = 0.55$
Wooldridge test for autocorrelation in panel data H_0: no 1st-order autocorrelation F(1,10)=141.386, p>F=0.00	σ_e	1.091	1.02	-
	ρ	0.991	-	-

t-statistics in parentheses, alternatively z-statistics for the AB estimation. *p < 0.05, ** p < 0.01, *** p <0.001.
Data source: Eurostat.

size. Following the FE cluster estimation, adding one standard deviation of population now yields a decrease in growth of 14.4[10] standard deviations (against 4.5 previously). The coefficients on population are significant in all econometric specifications (except for the GLS estimator, that I reported for the purpose of comparing and assessing the country effects) and substantially negative. The result also holds in the dynamic setting (fourth column). The coefficient on population provided by the AB estimator measures the relationship between changes in population and changes in GDP growth, so that in the medium term, a positive change in population is associated with a negative change in growth. The coefficient on lagged growth is small and insignificant, so a persistence effect of GDP growth could not be pinned down. As already explained, since large countries are comparatively more closed, I dropped trade openness from the regressions and replaced it with domestic demand. Domestic demand– made up of the sum of domestic demand and investment as a percentage of GDP – is on average higher in larger economies of our sample for both components. Its impact on growth seems however much more limited than that of trade openness, which can possibly be explained by Germany's structurally low internal demand and its exports performance. The coefficient on the deficit gap is positive and significant with all estimators, confirming a correlation between expansionary fiscal policies and GDP growth in large countries (fiscal multiplier argument). However, given the high correlation between the deficit gap and domestic demand (-0.69), as well as the significance interactions on their coefficients, multicolinearity cannot be ruled out and limits the robustness of our results.

Table 5.5 presents the results for small countries. The FE estimator predicts a decrease of 19.4 standard deviations of growth with an additional standard deviation in population (see summary stats Table C-1 in the Appendix for computation). Comparatively to large countries with domestic demand, and as expected, openness has a greater and more significant correlation with growth (here, the coefficient on domestic demand was very small and was therefore dropped from the regressions). However, the hypothesis that their larger inflation rates foster their growth (real interest rate effect) is not confirmed by the regressions. On the contrary, upon closer inspection of the data, it seemed that small eurozone economies tended to go through episodes of short-lived inflationary growth (i.e., inflation soared with high growth rates, and in the next period, high inflation eroded growth). In addition, with a positive, large and significant coefficient on lagged growth, the AB estimator highlighted a persistence phenomenon at play in small countries.

[10]Computed as previously using Table C-1 in the Appendix.

Table 5.4: Regressions of GDP growth in the large eurozone countries, 1998–2008

Estimation method (error specification)	**GLS (hetero AR)**	**Fixed Effects** (cluster)	**Fixed Effects (AR)**	**Arellano–Bond (AR)**
Population	0.00284	-1.367***	-1.442*	-1.302***
	(0.08)	(-91.62)	(-2.82)	(-4.05)
Domestic Demand	0.0619	0.347**	0.391*	0.455***
	(0.86)	(18.21)	(2.44)	(3.34)
Output per 1000 km^2	-0.444	2.873**	3.464	2.092***
	(-1.65)	(15.43)	(1.53)	(3.65)
Inflation gap	0.274	0.144	0.203	0.438*
	(0.97)	(0.97)	(0.44)	(2.45)
Deficit gap	0.894***	0.633**	0.602**	0.780***
	(6.48)	(24.71)	(2.96)	(8.63)
Lagged GDP growth				-0.0933
				(-0.40)
Constant	-2.971	46.27**	44.42*	34.76*
	(-0.38)	(30.48)	(2.58)	(2.16)
N	30	30	27	27
R^2 **within**	-	0.637	0.625	H_0: no 1st-order auto-correlation, $p = 0.25$
σ_u	-	15.11	15.55	H_0: no 2nd-order auto-correlation, $p = 0.68$
σ_e	-	0.705	0.745	-
ρ	-	0.998	-	-

t-statistics in parentheses, alternatively z-statistics for the AB estimation. *p < 0.05, ** p < 0.01, *** p <0.001.
Data source: Eurostat.

Table 5.5: Regressions of GDP growth in the small eurozone countries, 1998–2008

Estimation method (error specification)	**GLS (hetero AR)**	**Fixed Effects (cluster)**	**Fixed Effects (AR)**	**Arellano–Bond (AR)**
Population	0.536*	-7.758***	-7.438**	-7.686***
	(2.41)	(-12.62)	(-3.28)	(-3.92)
Trade Openness	4.075*	7.141**	7.657**	8.041*
	(2.27)	(3.94)	(3.16)	(2.29)
Output per 1000 km^2	-0.696**	1.434**	1.317	1.862*
	(-3.02)	(4.18)	(1.26)	(2.54)
Inflation gap	-0.323	-0.666***	-0.585**	-1.117***
	(-1.80)	(-7.50)	(-3.04)	(-8.98)
Deficit gap	0.0559	0.123	0.168	0.109
	(0.68)	(0.68)	(1.34)	(0.78)
Lagged GDP growth				0.312*
				(2.52)
Constant	-3.011	61.32***	58.03***	57.21***
	(-1.03)	(10.85)	(4.43)	(3.93)
N	75	75	68	69
R^2 **within**	-	0.528	0.392	H_0: no1st-order auto-correlation, $p = 0.03$
σ_u	-	27.27	26.52	H_0: no 2nd-order auto-correlation, $p = 0.47$
σ_e	-	1.068	1.056	-
ρ	-	0.998		-

t-statistics in parentheses, alternatively z-statistics for the AB estimation.
*p $<$ 0.05, ** p $<$ 0.01, *** p $<$0.001. Data source: Eurostat.

In these large and small countries analyses, one eurozone country was left out: Spain. Indeed having a separate "medium-sized" category for it proved *a posteriori* sensible. Though Spain does not exactly fit the large eurozone country profile, a regression including the "three big" and Spain was run. Though it obviously included with more observations, the R^2 dropped slightly, the significance results were roughly the same, the coefficient on size was less negative and the inflation gap coefficient changed signs without gaining significance. The inclusion of Spain in the small countries regression proved even less appropriate. In this case, the R^2 dropped to a maximum of 0.35, population and trade openness lost all significance. Only the significance of the inflation gap was boosted. These results confirm that Spain falls into a size category of its own, sharing with the large countries a weaker reliance on exports and displaying inflationary growth as is the case of several smaller countries, but having overall economic structures pertaining neither to small nor large economies.

To better fathom and round up the results of the different regressions this far, Table 5.6 presents a comparison of the regression coefficients in terms of size and significance. Since the coefficients in the FE model regression are constrained across units, comparing regression coefficients obtained for large countries and small countries is a good way to check the empirical incidence of country size on economic performance. While coefficients always bear the same sign for both groups, there still are a number of sizeable differences. As far as population is concerned (my proxy for country size), the correlation is large in both groups, with a more negative impact on growth for the eleven small countries than that for the three large ones (one additional standard deviation of population leading to a decrease of 14.4 standard deviations in large countries and 19.4 in small ones), confirming an advantage to micro-states in the likes of Luxembourg, Malta and so forth in the monetary union. Trade openness yielded the largest and most significant coefficients, especially in the case of small countries. This confirms the findings of Alesina, Spolaore, and Wacziarg (2005) that the smaller the country, the larger the positive correlation between openness and growth. Domestic demand bears no significant coefficient for small countries and a moderate positive impact on the growth variations in large countries.

The measure for territorial efficiency has a positive and significant coefficient in both small and large country regressions and a negative sign in the "pooled" one. This is partly explainable by the fact that this variable does not have a linear relationship with size, as large countries are more territorially efficient than the small new entrants countries catching up with their European counterparts. The most interesting results for the hypothesis regarding the effects of the eurozone economic government on different-

Table 5.6: Comparison of regression coefficients for GDP growth: range and significance

	Large countries	Small countries	eurozone (15 countries)
Population	[-1.442***; -1.302***]	[-7.686***; 0.536*]	[-0.0203*-0.342*]
Trade Openness	0.0524**	[4.075*; 8.041*]	[7.980***; 12.16**]
Domestic Demand	[0.347**; 0.455***]	No significance	0.215*
Output per 1000 km^2	[2.092***; 2.873**]	[1.434**,1.862*]	[-1.431**; -0.238*]
Inflation Gap	0.438*	[-1.117***; -0.585***]	[-1.089***; -0.425*]
Deficit Gap	[0.602**; 0.894***]	No significance	No significance
Lagged GDP growth	No significance	0.312*	No significance
Σ_u	[15.11; 15.55]	[26.52; 27.27]	[11.42-13.68]

*p $<$ 0.05, ** p $<$ 0.01, *** p $<$0.001. Data source: Eurostat.

sized countries are those for the inflation and deficit gaps. The correlation between the inflation gap and growth is negative and very significant in small countries, while it is smaller in absolute value, positive and seldom significant in large ones. Computing standard deviations effects from the regression coefficients as previously, shows that one additional standard deviation of inflation depresses growth by -0.48 standard deviation (FE cluster) and up to -0.81 (AB estimator) in small countries, while this effect ranges between $+0.08$ and $+0.24$ for large countries. Looking at the correlation between growth and inflation, it seems that their fluctuations are moderately correlated if we take all countries (correlation coefficient -0.3081, see Table 5.3). Upon closer inspection, however, there is a strong positive correlation in small countries between growth and future (at $t+1$) inflation (0.5751). For new entrant countries and the countries that have been catching up (most notoriously Ireland), either the Balassa-Samuelson effect has been at play or rapid growth has fuelled inflation. In large countries, the correlation between inflation and growth was negative but small (-0.2774) and the coefficient on the inflation gap was only significant with the AB dynamic estimator. Different interaction mechanisms between growth and inflation in large and small countries in the eurozone thus seem at play. In addition, the existence of an inflation externality generated by small countries cannot be ruled out.

Turning now to the deficit gap: its effect on growth is positive for large countries, thus corroborating the domestic demand-based growth argument; and difficult to pin down for small countries in line with the expectation that these countries rely on external demand for their growth and so have smaller fiscal multipliers. For large countries (notwithstanding multicolinearity between the deficit gap and domestic demand as explained earlier), the computed effect of the deficit gap on growth ranges between 0.15 (FE cluster) and 0.73 (AB) additional standard deviation. Correlation values confirm

these size-dependent differences: the present and past deficits are positively correlated with growth (at the respective levels of 0.4090 and 0.5135) in large countries, while these values are much lower in smaller countries.

5.3.5 Robustness Checks Across Space and Time

To further substantiate the previous findings, I now show how the inverse relationship between country size and economic performance is specific to the monetary union. Taking "placebo" data sets either comprising comparable countries that opted out of the eurozone or years of data for the eurozone countries before the launch of the monetary union, I run robustness checks with similar regressions. I found no relationship for comparable countries not participating in the monetary union over the same time span, and that there was no such "size-divide" phenomenon at play in the 15 countries studied before the launch of the monetary union.

More explicitly, I take first one small and one large EU country, Sweden and the United Kingdom, as counter-examples of the "size divide" in terms of economic performance: Table 5.7 shows the absence of a sizeable and significant relationship between their size and their GDP growth. (The pooled OLS yielded a significant result, but the coefficient was too small to be meaningful.) Notwithstanding the small size of the sample, in the EU the "size divide" appears delimited by the eurozone frontiers.

Table 5.7: Regressions of GDP growth in Sweden and the United Kingdom, 1998–2008

Sweden and United Kingdom 1998–2008	**Pooled OLS**	**Fixed Effects (cluster)**	**Fixed Effects (AR)**	**Arellano–Bond (AR)**
Population	-0.0129*	0.00777	0.0174	0.00773
	(-42.72)	(7.54)	(0.09)	.
Lagged GDP growth				0.304
				.
Constant	3.219**	2.215*	1.709	1.435
	(187.4)	(44.37)	(0.25)	.
N	57	57	55	56
R^2 **within**	-	0.0000625	0.000151	-
σ_u	-	0.708	0.995	-
σ_e	-	1.708	1.656	-
ρ	-	0.147	-	-

t-statistics in parentheses, alternatively z-statistics for the AB estimation.
*p $<$ 0.05, ** p $<$ 0.01, *** p $<$0.001. Data source: World Bank.

Now, using the 1960–2007 data set, I sectioned the data set along two milestones of European monetary integration: first, the introduction of the European Monetary System (EMS) in 1979 that paved the way for the EMU as it linked national currencies to each

other within a fluctuation band and; second, the actual launching of the monetary union in 1999. Table 5.8 presents the estimation results of the regressions, with the same AB estimator as previously. I estimated the same dynamic model, separately for small and large countries, over the 1960–1979 and 1980–1999 periods.

Table 5.8: Regressions of GDP growth in the pre-monetary union period, 1960–1999

Arellano–Bond (AR)	**All countries**		**Small countries**		**Large countries**	
Time period	***1960–1979***	***1980–1999***	***1960-1979***	***1980–1999***	***1960–1979***	***1980–1999***
Lagged GDP growth	-0.0638	0.303***	-0.0163	0.292**	-0.136**	0.410***
	(-0.76)	(3.34)	(-0.22)	(2.97)	(-2.99)	(3.77)
Population	-0.872	-0.159	-2.196**	-0.0305	-3.168**	0.0476
	(-1.77)	(-1.71)	(-2.93)	(-0.09)	(-2.83)	(0.75)
Trade Openness	16.53***	8.679***	15.07***	8.751***		
	(10.19)	(6.28)	(13.39)	(5.94)		
Output per 1000 km^2	-1.252	-0.222	-0.848***	-0.208	20.29***	-2.966***
	(-1.88)	(-1.47)	(-3.53)	(-1.55)	-9.23	(-3.41)
Inflation gap	-0.0922	-0.0739**	-0.148*	-0.0745**	-0.754***	-0.176***
	(-1.43)	(-2.90)	(-2.12)	(-2.71)	(-12.40)	(-7.97)
Deficit gap	0.423*	0.061	0.521***	0.0625	-1.565***	-0.0752
	(2.42)	(1.92)	(3.51)	(1.87)	(-92.43)	(-0.40)
Domestic Demand					-0.663***	-0.242*
					(-14.54)	(-2.20)
Constant	10	-1.577	14.62	-5.023	225.2***	33.73**
	(1.3)	(-0.55)	(1.6)	(-1.32)	(3.71)	(3.07)
N	83	259	68	211	15	48

z-statistics for the AB estimation. *p $<$ 0.05, ** p $<$ 0.01, *** p $<$0.001. Data source: World Bank.

Strikingly enough, the coefficient on size was important, negative and significant for small and large countries between 1960 and 1979. As the coefficient on trade for small countries is also very large, the industrial development and integration of the smaller European countries into the global markets that characterised this period, as described by Katzenstein (1985), could explain the negative correlation between population and GDP growth. Between 1980 and 1999 – the preparatory phase of the monetary union – , the effect of country size on economic performance is smaller and insignificant. This result strongly corroborates the contention that the eurozone "size divide" stems from the economic policy settings of the monetary union.

Notwithstanding that I can only identify correlations and not directly causational effects, country size seems to have a good explanatory power in accounting for growth

differences in the eurozone.[11] All used estimators indicated an adverse effect of country size on economic growth. My analysis encompassed different components of growth and corroborated that the economic structures of small countries are more apt to foster growth in the framework of the monetary union.

When I introduced country and time effects (see Table C-2 in the Appendix), the estimated pair-wise correlations exhibited less significance in the complex panel data analysis, however, temporally widening the data set or running the same regressions on EU countries that opted out of the monetary union, yielded the results I expected and bestowed the first finding with a substantial robustness across time and space. Country effects (measured by σ_u) and their incidence on the total variance (measured by ρ) were in all FE estimations large, meaning that national peculiarities in the variables I controlled for played a non-negligible part in growth differences. And there are certainly other reasons possible for explaining these differentiated economic performances that were not taken into account in the analysis. Another limit to the analysis is that of a *selection bias* in our sample as described by Persson (2001), meaning that the measured size effect could be magnified by unaccounted for characteristics of countries belonging to the monetary union. Indeed, one could claim that most EMU members are small open economies because they are precisely the ones more prone to benefit from a monetary union and consequently the size bias would be tautological. Subtracting the selection bias with the Heckman method requires the probability of belonging to a monetary union. The sample of countries on which that probability should be computed is not clear. If we compute propensities on all countries then we are not assessing the monetary union treatment effect with all other things held equal. Likewise, restricting the sample to advanced economies is not satisfactory as it neglects important factors of monetary union membership such as geographic continuity or cultural closeness. There thus is a number of rationale against which to test the monetary union treatment effect. Comparability demands selection which in turn is subject to the " convergence by construction" critique of De Long (1988). The negative correlation between country size and GDP growth, while still robust, may in fact be smaller. Furthermore, the negative incidence of country size on GDP growth in the EMU cannot support the break-down of the monetary union into NUTS-3 regions as each country is a collection of regions with different growth rates. From the analysis on territorial efficiency, we may only induce that larger countries tend to have a lower ratio of fast-growing regions to slow-growing regions.

[11] The same regressions were run excluding the potential outliers. These outliers included Ireland and Luxembourg (small countries with very high growth rates over the last decade) and yielded roughly the same significance levels.

Conclusion

Country size determines a number of economic structures; in the EMU it also impacts on economic performance. As far as economic structures are concerned, a greater openness is observed in smaller countries and a heavier reliance on internal demand is observed in larger countries. In the context of the EMU and its economic rules, these features influence economic performance because the "one-size-fits-all" rules are biased in favour of the growth strategies of small countries. On the one hand, the SGP constrains larger countries in their ability to fiscally boost internal demand; on the other hand the ECB cannot internalise the negative externality generated by small countries because of their usually higher inflation and encourages price competitiveness policies. There is therefore a clear asymmetry in the benefits of EMU membership between small and large countries. In this paper, I documented the emergence of a "size divide" within the eurozone – that is, a sizeable negative effect of demographic size on GDP growth – with an econometric analysis for the 1998–2008 decade, and for the 15 countries in the euro area (as of Jan. 1st 2008). The econometric analysis ran separately for large and small countries using dynamic panel estimation methods, showed an even stronger negative "size effect" for small countries. All estimators used concurred on the adverse effect of country size on economic growth, so that the results obtained are robust to different econometric specifications. Further robustness checks consisted in enlarging the scope of the data to run "placebo" regressions on the pre-monetary union period and on countries that opted out of the monetary union. They confirmed that the "size divide" was indeed a by-product of the monetary union. Ironically enough, Germany and France, two large countries, presided over the making of the monetary union, and so bear a responsibility for their own disadvantaged economic fate in the eurozone. However, the fact that large countries are economically disadvantaged by the workings of the EMU is a problem for the eurozone as a whole: harming these members – together representing 70% of the area's GDP, as well as absorbing a substantial share of other eurozone members' exports – , will eventually also hurt the smaller economies. Under such a scenario, the eurozone won't be able to live up to its role as a key international economic power and the euro may lose some of its international appeal.

Finally, it is sensible to extend the analysis of the impact of country size to the enlargement of the eurozone. Integration is a "shrinking process" and with each enlargement, the relative sizes of Member States within the monetary union diminish. Another factor altering country size is demographic change. As the population of some eurozone countries is

on the wane, while that of others grows, in the long run, the relative sizes of the Member States will evolve. Will this make the effect of country size on economic performance different and bring about new economic policy constraints? This question remains to be investigated. As proven by the reluctance of the larger new Member States (Poland, Hungary and the Czech Republic) to join the euro area rapidly, eurozone membership remains so far more propitious to small countries. Future theoretical research focussing on the modelling of country size and its implications for the conduct of economic policies in the monetary union should complete the empirical findings of this paper.

6 General Conclusion

"The power of economists to say anything declined as the cube of the number of economists present. The only hope for agreement was when only two were present: the author and his conscience!" Robinson (1960)

This dissertation argues that country size matters for economic growth, because size affects a country's openness to trade, domestic demand, and its institutional and territorial efficiency. This is particularly the case in the Economic and Monetary Union, where the Stability and Growth Pact and the European Central Bank make up a "one-size-fits-all" institutional and economic policy framework . It follows that in the eurozone the effects and spillovers of fiscal policy depend on country size and fuel the differentials observed between small and large countries. Therefore in a monetary union, size-appropriate fiscal policies are more conducive to growth. As the concept of country size is at the intersection of economics and political science, the approach was deliberately interdisciplinary.

First, we developed a micro-founded new Keynesian model of a two-country monetary union, which is apt to show the effects of different fiscal policies with cross-country heterogeneities in terms of size and openness. Second, resorting to the model previously developed, we analysed the effects of several fiscal policies in a monetary-union with countries of different sizes. As large economies rely more on domestic demand than small and open eurozone countries do, they react differently to fiscal stimuli. We found that small open economies benefit more from their neighbours' fiscal stimulus and that large economies are better off spurring domestic demand with increased public spending than in engaging in tax-cuts competition with their smaller neighbours. Third, taking an empirical perspective, we developed a country size index with Principal Component Analysis (PCA), which includes demographic, economic and territorial dimensions of country size. Using a panel of 163 countries with yearly data from 1969 to 2007, we showed empirically that country size is negatively linked to GDP growth and business cycle volatility independently of trade-openness. Finally, we examined the mechanisms at play in the EMU as the negative relationship between country size and growth became more pronounced. The emergence of a "size divide" was explained with a political

economy analysis of the eurozone's fiscal and monetary rules and shown econometrically to be correlated with the creation of the monetary union.

Current developments – especially the financial and sovereign debt crises of 2010-11 – underline the relevance of country size in the eurozone. *The Economist*[1] argued that "the laziest distinction that investors are now making between markets is based on size. Indeed public revenues are backed by a more diversified economy in larger countries and their bond markets attracts more investors who prize liquidity. That is a particular worry for Portugal, which is less of a credit risk than Greece but is vulnerable because it is so small[...]Bigger bond markets are less easy to abandon". These imbalances are traceable to the launch of the single currency. The adoption of the euro brought about a drop in the interest rates and cheap credit fuelled the booms in uncompetitive small economies. Meanwhile in the past decade, Germany introduced a wage moderation policy that lowered labour-costs and raked in large trade-surplus from its eurozone partners. Because of its size, Germany imparted a deflationary bias onto the rest of the eurozone. But Germany now needs to find new sources of growth and rebalance it towards domestic demand as its partners cannot sustain deficits forever. This growth paradigm is inappropriate for single countries that cannot replicate Germany's market position and also unfit for the eurozone as a whole, as it is too large to rely more on demand outside of the EU. To this end, unions are pushing for a minimum wage – boosting demand and imports – , whereas more liberal options include more low-wage jobs to strengthen the services sector. However, Alesina and Perotti (2010) warned that Germany's spending is not the cure; the real problem resides in supply-side rigidities, and the specialisation of uncompetitive sectors such as construction in peripheral eurozone economies. There, "internal devaluation" could be a catalyst to regain lost competitiveness: increasing VAT while decreasing payroll taxes would shift economies away from domestic demand and towards exports.

The global rebalancing needed within the eurozone underlines the issue of efficient fiscal policy rules design. The 440 billion euro rescue plan set up in the wake of the Greek crisis confirms indeed that monetary union brings about *de facto* fiscal federalism. There is, however, no consensus on the fitness of the fiscal rules of the EMU with regards to fiscal solvency. While Canzoneri, Cumby, and Diba (2001) deem them unnecessarily stringent, Sims (1999) contends that they cannot eliminate the insolvency risk highlighted by the fiscal theory of the price level. Redesigning the Stability and Growth Pact also necessitates that the punishments for excessive fiscal profligacy not impair those inflicting them, so

[1] *That sinking feeling*, May 22nd, 2010.

that Member States do not actually hurt themselves by enforcing fiscal discipline. Burda and Gerlach (2010) proposed, for instance, to "reallocate costs of running Europe from the countries that have their house in order to those that don't", by imposing a surcharge on additional debt distributed amongst Member States according to their contribution to the EU budget. Furthermore, the sovereign-debt crisis has demonstrated that price stability alone is no bulwark against economic and financial turmoil and has made the ECB's involvement in vouching for public debt and the credibility of public finances figures necessary. The difficulties of peripheral economies qualify the benefits to a small country of belonging to a currency union. On the one hand, export competitiveness proves hard to gain back and on the other hand, investors can inflict considerable spreads even on euro-denominated sovereign bonds.

Fiscal policy coordination is often wished for but hard to implement. For reasons of political and national preferences, countries have conflicting objectives that go even beyond the size differences we detailed in this thesis. Coordination may be efficient in dealing with supply shocks as it prevents fiscal and monetary policy from going in divergent directions but benefits seem narrower in the face of demand shocks. For instance, in the aftermath of the crisis, small open economies have stronger incentives to start re-tightening their fiscal policies as most of their gains from loose fiscal policy spill abroad. Rather than seeking complex coordination, fiscal policy should concentrate more realistically on the composition of aggregate demand, the level of taxation and redistribution so as to increase national potential output.

We thus hope to have provided a relevant grid to think about country size, national heterogeneity and their implications for the conduct of economic policy in the monetary union. In short, our contribution to the debate is that the negative scale effect of country size on growth is especially acute in the monetary union, so incorporating country size into the design of fiscal policy is essential for national growth performance. Much remains to be done. As the implementation of EMU is very recent,the economic effects of EMU still unfold before our eyes and we have only limited hindsight. There is not yet an apparatus of economic models that capture all of its institutional features. We are now learning how common European rules can be adapted to specific national conditions and structures, deciphering which institutional settlements induce which economic developments.

The size patterns in the EU and EMU are evolving as populations grow older, national demographic developments diverge and new Member States join. If Turkey were to enter the union and Germany's demographic decline were to continue, it could be the fourth country by population in the EU by 2050 and its economy will shrink relative

to that of its neighbours. Further modelling of country size should also consider the regional level. This is of economic relevance as disparities in terms of economic activity are often larger within eurozone countries than between them. The EU has also been a source of political empowerment for regions, especially for rich ones voicing separatist claims. Empirically, a worthwhile econometric experiment would be to regress growth performance on region size within one same country so as to determine whether it is really country size that matters or just the size of a given economic territory. Interestingly enough, the unwillingness of separatist regions to pay for the development of poorer ones has mirrored the power games between Member States that came in the wake of the Greek sovereign debt crisis. Such fiscal "selfishness" undermines the convergence of Member States and should be condemned by the EU. This would convey the message that a Member State cannot expect to reap the benefits of the Union while refusing to share the burdens that are a legitimate part of membership. Furthermore, there is no interest on the part of the EU to have regional members; functioning with 27 members is already complex enough. In spite of globalisation and regionalisation, the nation – regardless of its size – remains the relevant unit for the conduct of economic policy.

Appendix A – Country Size Matters: Fiscal Policy and Spillovers in the EMU

Assessing the impact of the elasticity of substitution of consumption σ_c

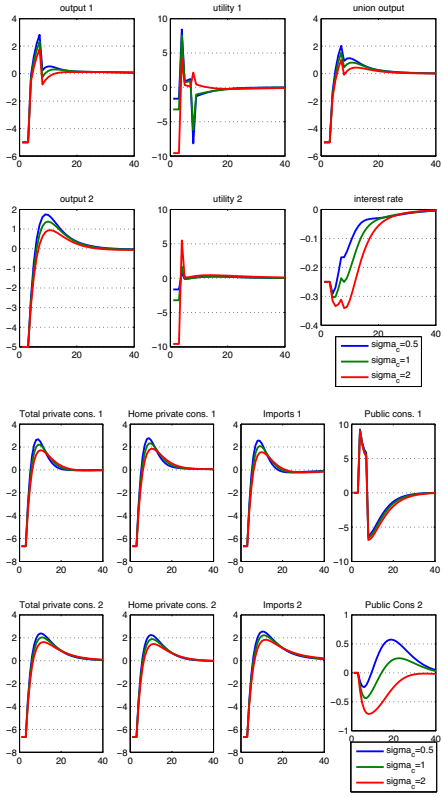


Figure A-1: Comparing responses to an increase in government spending with different σ_c values

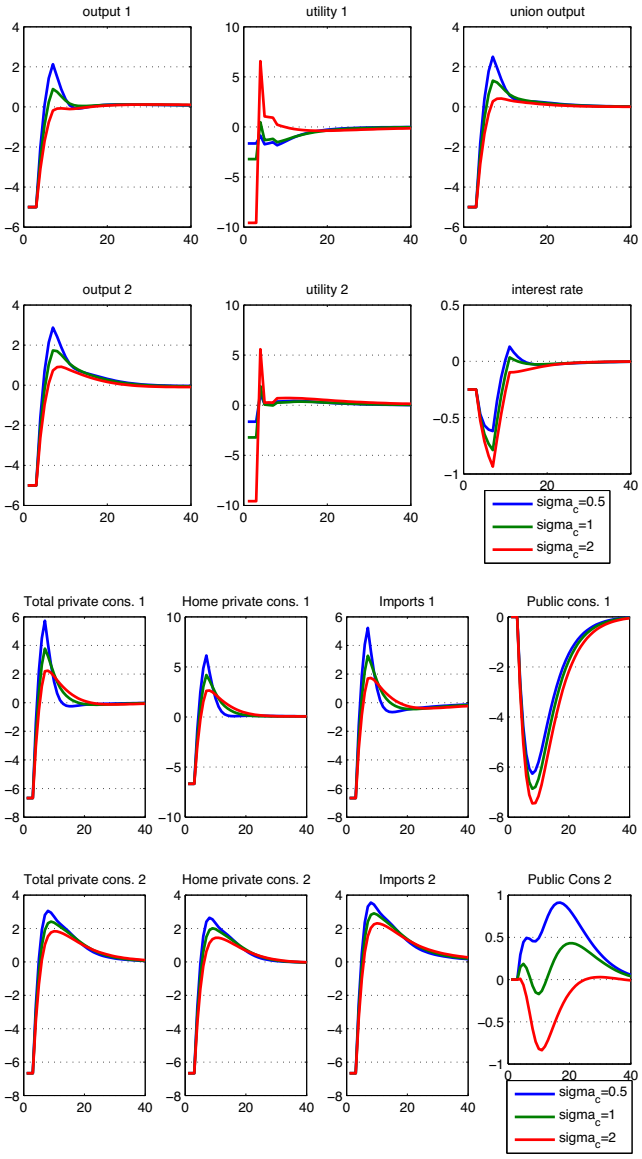


Figure A-2: Comparing responses to a VAT cut with different σ_c values

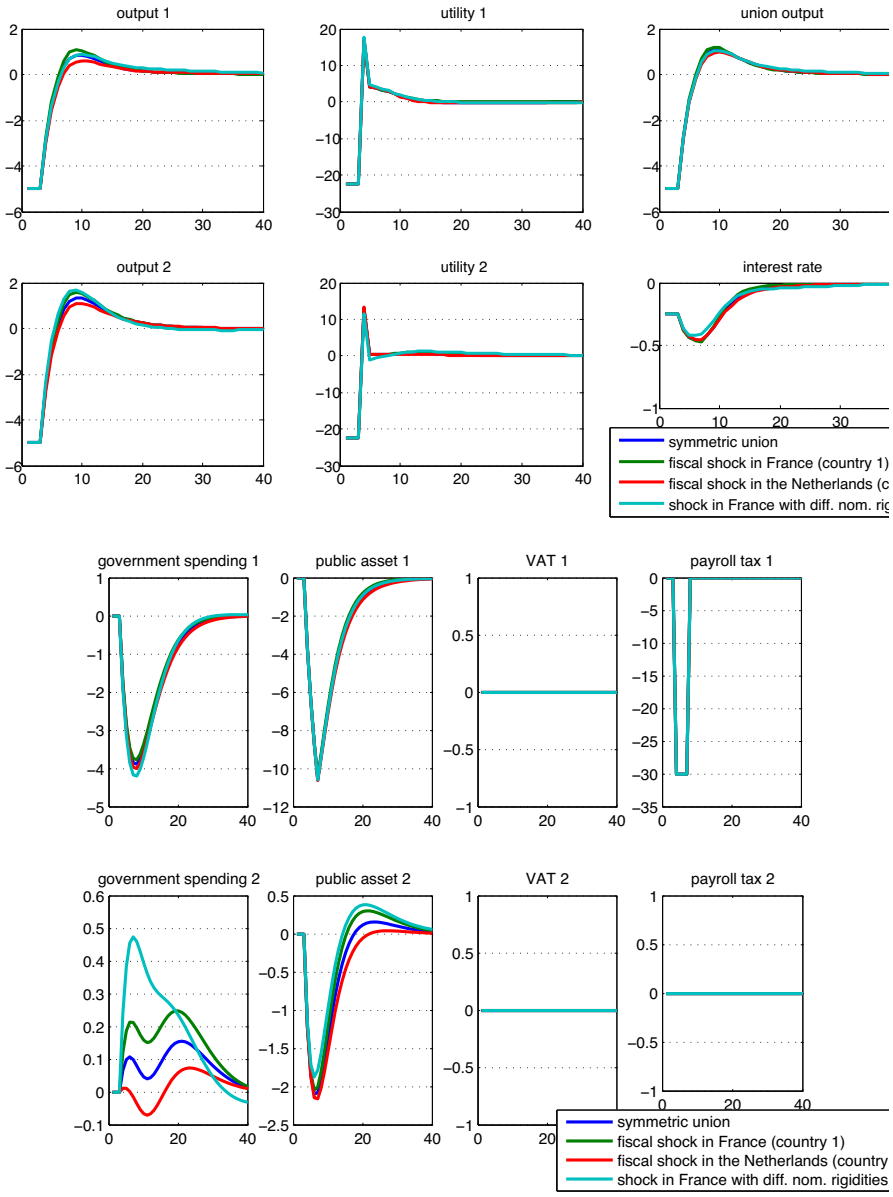


Figure A-3: Effects and spillovers of a cut in the payroll tax – 1 of 3

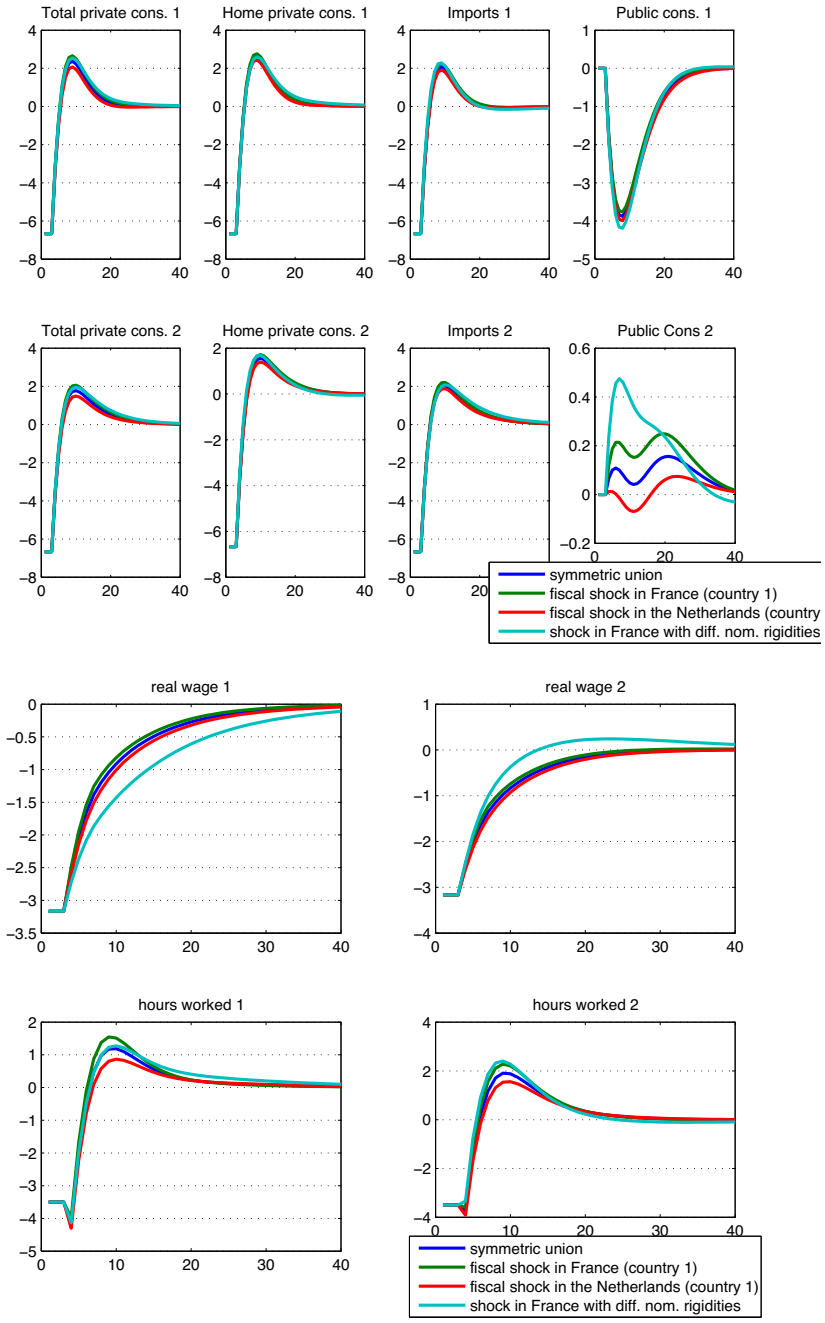


Figure A-4: Effects and spillovers of a cut in the payroll tax – 2 of 3

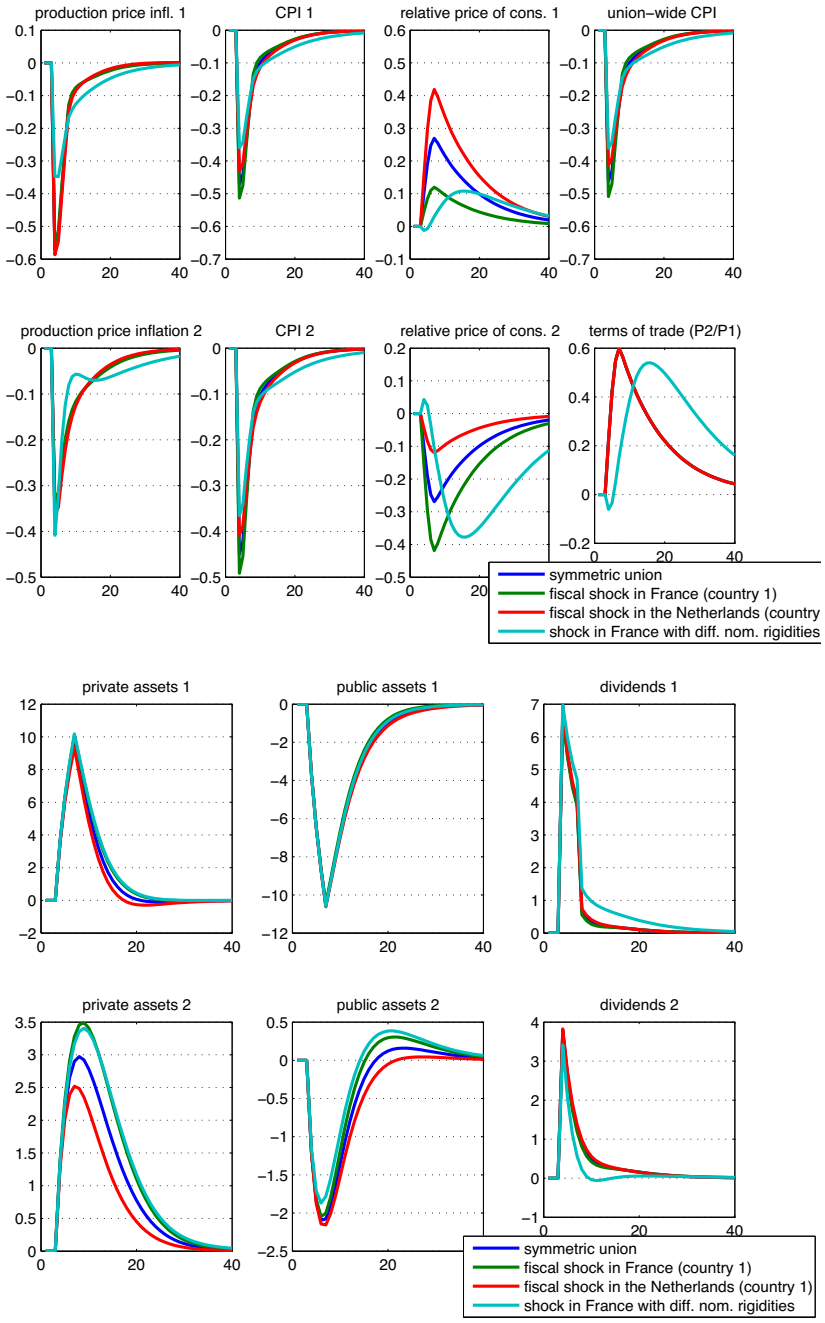


Figure A-5: Effects and spillovers of a cut in the payroll tax – 3 of 3

Appendix B – Country Size, Growth and Volatility

Table B-1: List of countries

List of countries			
Albania	Eritrea	Mali	Suriname
Algeria	Estonia	Malta	Swaziland
Angola	Ethiopia	Marshall Islands	Sweden
Antigua and Barbuda	Finland	Mauritania	Switzerland
Argentina	France	Mauritius	Syrian Arab Republic
Armenia	French Polynesia	Mexico	Tajikistan
Australia	Gabon	Micronesia, Fed. Sts.	Tanzania
Austria	Gambia, The	Moldova	Thailand
Azerbaijan	Georgia	Mongolia	Togo
Bahamas, The	Germany	Morocco	Tonga
Bahrain	Ghana	Mozambique	Trinidad and Tobago
Bangladesh	Greece	Namibia	Tunisia
Barbados	Grenada	Nepal	Turkey
Belarus	Guatemala	Netherlands	Turkmenistan
Belgium	Guinea	New Caledonia	Uganda
Belize	Guinea-Bissau	New Zealand	Ukraine
Benin	Guyana	Nicaragua	United Arab Emirates
Bhutan	Haiti	Niger	United Kingdom
Bolivia	Honduras	Nigeria	United States
Bosnia and Herzegovina	Hong Kong, China	Norway	Uruguay
Botswana	Hungary	Oman	Uzbekistan
Brazil	Iceland	Pakistan	Vanuatu
Bulgaria	India	Palau	Venezuela, RB
Burkina Faso	Indonesia	Panama	Vietnam
Burundi	Iran, Islamic Rep.	Papua New Guinea	Yemen, Rep.
Cambodia	Iraq	Paraguay	Zambia
Cameroon	Ireland	Peru	Zimbabwe
Canada	Israel	Philippines	
Cape Verde	Italy	Poland	
Central African Republic	Jamaica	Portugal	
Chad	Japan	Puerto Rico	
Chile	Jordan	Romania	
China	Kazakhstan	Russian Federation	
Colombia	Kenya	Rwanda	
Comoros	Kiribati	Samoa	
Congo, Dem. Rep.	Korea, Rep.	Saudi Arabia	
Congo, Rep.	Kyrgyz Republic	Senegal	
Costa Rica	Lao PDR	Seychelles	
Cote d'Ivoire	Latvia	Sierra Leone	
Croatia	Lebanon	Singapore	
Cyprus	Lesotho	Slovak Republic	
Czech Republic	Liberia	Slovenia	
Denmark	Lithuania	Solomon Islands	
Djibouti	Luxembourg	South Africa	
Dominica	Macao, China	Spain	
Dominican Republic	Macedonia, FYR	Sri Lanka	
Ecuador	Madagascar	St. Kitts and Nevis	
Egypt, Arab Rep.	Malawi	St. Lucia	
El Salvador	Malaysia	St. Vincent and the Grenadines	
Equatorial Guinea	Maldives	Sudan	

Table B-2: Large countries

Large Countries		
Argentina	Germany	Russian Federation
Australia	India	Spain
Brazil	Indonesia	Turkey
Canada	Italy	United Kingdom
China	Japan	United States
France	Mexico	

Table B-3: Summary statistics

Summary Statistics					
All Countries					
Variable	**Nb. Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Lpop	8424	1.441	2.021	-4.200	7.185
indexLpcar	6645	0.000	1.551	-4.368	3.905
indexjar	6645	0.656	1.850	0.000	18.951
gdp_growth (%)	6654	3.937	6.385	-51.03	106.28
trade_op (%)	6325	0.751	0.462	0.053	4.625
real_ir (%)	3725	6.241	19.620	-98.15	789.80
inflation_cp (%)	5583	34.44	410.04	-17.64	23773.13
Large countries					
Variable	**Nb. Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Lpop	665	4.555	1.148	2.350	7.185
indexLpcar	665	2.543	0.549	1.985	3.905
indexjar	665	4.490	4.136	0.916	18.951
gdp_growth (%)	663	3.863	4.131	-27.10	19.40
trade_op (%)	637	0.346	0.176	0.053	1.106
real_ir (%)	454	5.759	9.819	-24.60	78.73
inflation_cp (%)	594	46.366	248.44	-7.63	3079.81
Small countries					
Variable	**Nb. Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Lpop	5980	1.316	1.777	-3.927	5.090
indexLpcar	5980	-0.283	1.357	-4.368	1.985
indexjar	5980	0.230	0.294	0.000	1.710
gdp_growth (%)	5903	3.914	6.529	-51.03	106.28
trade_op (%)	5404	0.779	0.429	0.063	4.625
real_ir (%)	3233	6.329	20.726	-98.15	789.80
inflation_cp (%)	4679	33.89	438.21	-17.64	23773.13
OECD					
Variable	**Nb. Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Lpop	1440	2.596	1.518	-1.737	5.709
indexLpcar	1310	1.152	1.133	-1.933	3.905
indexjar	1310	1.598	3.060	0.018	18.95
gdp_growth (%)	1302	3.555	3.029	-14.570	18.710
trade_op (%)	1253	0.659	0.407	0.093	3.266
real_ir (%)	820	4.414	4.166	-19.490	16.75
inflation_cp (%)	1285	9.024	21.110	-0.900	555.38
Eurozone, post 1999					
Variable	**Nb. Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Lpop	135	1.998	1.688	-0.947	4.413
indexLpcar	134	0.541	1.344	-2.403	2.384
indexjar	134	0.606	0.763	0.006	2.639
gdp_growth (%)	134	3.111	1.976	-1.610	10.720
trade_op (%)	113	1.093	0.640	0.440	3.266
real_ir (%)	86	3.765	2.668	-2.650	11.640
inflation_cp (%)	135	2.592	1.335	0.190	8.880
BRICs, post 2000					
Variable	**Nb. Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Lpop	32	6.080	1.012	4.953	7.185
indexLpcar	32	3.145	0.470	2.563	3.837
indexjar	32	6.497	3.905	2.634	12.772
gdp_growth (%)	32	6.903	2.943	1.270	11.900
trade_op (%)	31	0.439	0.159	0.217	0.720
real_ir (%)	32	12.600	19.380	-9.630	47.680
inflation_cp (%)	32	6.918	5.599	-0.770	21.460

Appendix C – Country Size and Economic Performance in the Eurozone

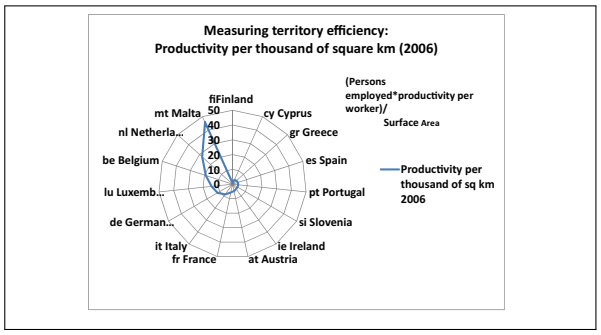


Figure C-1: Territorial efficiency relative to productivity

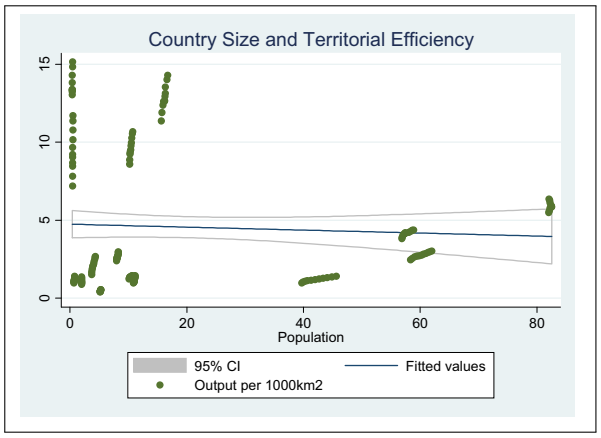


Figure C-2: Country size and territorial efficiency: a non-linear relationship

Table C-1: Summary statistics

Summary Statistics					
15 eurozone countries, 1998–2008, Source: Eurostat					
Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
GDP growth,%	162	3.12	1.93	-1.61	10.73
Population, million	165	20.76	25.59	0.38	82.54
Trade openness	163	1.11	0.62	0.47	3.24
Domestic demand,%	148	97.67	8.43	69.40	113.50
Output per 1000km^2	163	4.55	4.36	0.40	15.15
Inflation gap, %	165	0.59	1.34	-1.86	6.81
Deficit gap, %	121	1.81	2.66	-5.41	9.63
Large eurozone countries, 1998–2008, source: Eurostat					
Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
GDP growth,%	33	1.69	1.07	-0.27	3.91
Population, million	33	66.73	11.27	56.86	82.54
Trade Openness	33	0.59	0.11	0.47	0.90
Domestic demand,%	30	98.35	2.14	93.00	101.90
Output per 1000km^2	33	4.27	1.32	2.47	6.35
Inflation gap, %	33	-0.13	0.61	-1.44	0.81
Deficit gap, %	33	0.52	1.03	-1.05	3.03
Small eurozone countries, 1998–2008, source: Eurostat					
Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
GDP growth,%	118	3.48	2.00	-1.61	10.73
Population, million	121	6.27	5.09	0.38	16.70
Trade Openness	119	1.31	0.62	0.53	3.24
Domestic demand,%	108	96.95	9.61	69.40	113.50
Output per 1000km^2	119	4.93	4.94	0.40	15.15
Inflation gap, %	121	0.74	1.47	-1.86	6.81
Deficit gap, %	77	2.19	3.06	-5.41	9.63
15 eurozone countries, 1960–2007, source: World Bank					
Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
GDP growth,%	648	3.75	3.06	-8.90	20.27
Population, million	720	19.27	24.16	0.32	82.50
Trade openness	642	0.85	0.53	0.15	3.27
Domestic demand,%	609	106.35	8.48	80.57	137.37
Output per 1000km^2	654	2.53	2.60	0.10	13.10
Inflation gap, %	642	3.74	5.40	-2.88	30.86
Deficit gap, %	481	2.49	4.52	-12.32	16.75
Large eurozone countries, 1960–2007, source: World Bank					
Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
GDP growth,%	130	2.85	2.07	-2.09	8.21
Population, million	144	63.01	11.73	45.70	82.50
Trade openness	130	0.43	0.11	0.25	0.85
Domestic demand,%	133	106.82	4.96	93.52	115.21
Output per 1000km^2	131	2.72	1.29	0.67	5.79
Inflation gap, %	110	3.39	4.76	-1.50	19.28
Deficit gap, %	107	3.29	1.78	-1.30	8.00
Small eurozone countries, 1960–2007, source: World Bank					
Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
GDP growth,%	518	3.98	3.22	-8.90	20.27
Population, million	576	8.34	9.84	0.32	44.90
Trade openness	512	0.96	0.54	0.15	3.27
Domestic demand,%	476	106.22	9.23	80.57	137.37
Output per 1000km^2	523	2.49	2.84	0.10	13.10
Inflation gap, %	532	3.81	5.53	-2.88	30.86
Deficit gap, %	374	2.26	5.01	-12.32	16.75

Table C-2: Determinants of GDP growth in the eurozone countries, 1998–2008

Fixed Effects (with time effects, cluster)	**all countries**	**all countries**	**(3)small countries**	**(4)large countries**
Population	0.113	-0.143	-2.973**	-0.595
	-1.86	(-0.67)	(-4.45)	(-2.22)
Trade Openness	0.0850***		0.0763***	
	-15.1		-11.94	
Output per 1000km^2	-0.0575	0.281	0.774***	7.227
	(-0.37)	-0.55	-8.59	-2.17
Inflation gap	-0.0224	0.24	0.036	0.0685
	(-0.22)	-1.55	-0.33	-0.61
Deficit gap	0.0243	0.0674	0.0508	-0.247
	-0.31	-0.8	-0.59	(-1.64)
Year 1999	0.173	0.193	0.251	-0.397
	-0.51	-0.51	-0.44	(-0.79)
Year 2000	-0.533	0.0121	-1.102	-0.443
	(-1.09)	-0.02	(-1.99)	(-0.39)
Year 2001	-2.450***	-2.016**	-3.027***	-2.797
	(-5.08)	(-3.68)	(-6.85)	(-2.30)
Year 2002	-2.819***	-2.623***	-2.962***	-3.945
	(-7.36)	(-5.61)	(-6.90)	(-3.18)
Year 2003	-2.810***	-2.732***	-2.833***	-4.187
	(-6.29)	(-4.61)	(-7.37)	(-3.50)
Year 2004	-1.900***	-1.497*	-1.811**	-3.119
	(-4.66)	(-2.47)	(-4.30)	(-2.24)
Year 2005	-2.533***	-1.942**	-2.347**	-3.909
	(-6.47)	(-3.54)	(-5.52)	(-2.34)
Year 2006	-1.950**	-1.13	-1.759**	-3.097
	(-4.14)	(-1.34)	(-3.71)	(-1.32)
Year 2007	-2.223***	-1.222	-1.867**	-3.666
	(-5.31)	(-1.51)	(-4.35)	(-1.57)
Year 2008	-3.757***	0	-3.483**	0
	(-7.80)	.	(-5.62)	.
Domestic Demand		0.0259		0.1
		-0.24		-1.6
Constant	-5.901*	4.442	21.01*	3.613
	(-2.76)	-0.52	-3.23	-0.14
N	119	108	75	30
R^2 **within**	0.765	0.656	0.807	0.952
σ_u	3.675	3.7	10.64	6.441
σ_e	0.698	0.821	0.744	0.332
ρ	0.965	0.953	0.995	0.997

t-statistics in parentheses. *p $<$ 0.05, ** p $<$ 0.01, *** p $<$0.001. Data source: Eurostat.

Table C-3: Determinants of GDP growth in the small eurozone countries, 1998–2008

Estimation method with time effects (error specification)	**GLS (hetero AR)**	**Fixed Effects (cluster)**	**Fixed Effects (AR)**	**Arellano–Bond (AR)**
Population	0.0464	-2.973**	-1.453	-6.784*
	-0.35	(-4.45)	(-0.81)	(-2.48)
Trade Openness	0.188	7.626***	8.376***	3.109*
	-0.19	-11.94	-5.35	-2.04
Output per 1000km^2	-0.0766	0.774***	0.25	1.217
	(-0.57)	-8.59	-0.45	-1.75
Inflation gap	0.244*	0.036	-0.0658	-0.593***
	-2.14	-0.33	(-0.41)	(-3.32)
Deficit gap	0.168***	0.0508	0.0785	-0.0496
	-3.54	-0.59	-0.91	(-0.72)
Year 1999	-0.0599	0.251	4.009***	
	(-0.52)	-0.44	-4.97	
Year 2000	-0.293	-1.102	2.982***	
	(-1.55)	(-1.99)	-4.53	
Year 2001	-3.254***	-3.027***	0.749	
	(-13.32)	(-6.85)	-1.27	
Year 2002	-3.250***	-2.962***	0.761	
	(-15.20)	(-6.90)	-1.34	
Year 2003	-2.759***	-2.833***	0.82	
	(-14.27)	(-7.37)	-1.45	
Year 2004	-1.743***	-1.811**	1.747**	
	(-7.47)	(-4.30)	-3.26	
Year 2005	-2.077***	-2.347**	1.169*	
	(-7.93)	(-5.52)	-2.48	
Year 2006	-0.688*	-1.759**	1.728***	
	(-2.54)	(-3.71)	-4.09	
Year 2007	-0.716*	-1.867**	1.577***	
	(-2.34)	(-4.35)	-3.93	
Year 2008	-2.441***	-3.483**	0	
	(-6.92)	(-5.62)	.	
Lagged GDP growth				0.439***
				-3.31
Year 2000				0.563
				-0.84
Year 2001				-1.184
				(-1.53)
Year 2002				-0.457
				(-1.43)
Year 2003				-0.666
				(-1.25)
Year 2004				0.438
				-0.8
Year 2005				-0.137
				(-0.50)
Year 2006				1.091***
				-6.69
Year 2007				0.826**
				-3.16
Constant	3.415*	21.01*	4.705	56.63**
	-2.27	-3.23	-0.3	-3.1
N	75	75	68	69
R^2 **within**	-	0.807	0.815	H_0: no 1st-order auto-correlation, $p = 0.03$
σ_u	-	10.64	6.544	H_0: no 2nd-order auto-correlation, $p = 0.47$
σ_e	-	0.744	0.716	-
ρ	-	0.995	-	-

t-statistics in parentheses, alternatively z-statistics for the AB estimation.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Data source: Eurostat.

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Selbständigkeitserklärung

Hiermit erkläre ich, die vorliegende Dissertation mit dem Titel „Country Size, Growth and the Economic and Monetary Union“ selbständig verfasst und nur die angegebene Literatur und angegebenen Hilfsmittel verwendet zu haben. Ich habe keine Hilfe von anderen als den in der Danksagung (Acknowledgements) erwähnten Personen erhalten.

Ich bezeuge durch meine Unterschrift, dass meine Angaben über die bei der Abfassung meiner Dissertation benutzten Hilfsmittel, über die mir zuteil gewordene Hilfe sowie über frühere Begutachtungen meiner Dissertation in jeder Hinsicht der Wahrheit entsprechen.

Berlin, den 5. April 2012 Olfa Alouini

Erklärung

Ich erkläre, dass ich mich noch keinem Doktorexamen unterzogen habe. Diese Dissertation wurde bisher in gleicher oder ähnlicher Form keiner anderen Prüfungsbehörde vorgelegt.

Berlin, den 16. August 2011 Olfa Alouini